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LECTURES.

Tuesday, March 1st.

Major-General STANHOPE, Vice-President, in the Chair.

NATIONAL DEFENCE, OR NEW STRATEGIES IN WARFARE.

By J. MACKINTOSH, Esq.

THE important question of rendering our navy more efficient as an arm of *attack* against Sea-face Fortifications is of such vital importance to the country, that I trust the following observations relative to the employment of combustible compounds in naval and military warfare may be considered worthy of attention.

In order more clearly to explain the nature of my remarks, I have classed them under five different heads—

1. Facilitating attack, by ships of war, against sea-face fortifications.
2. Facilitating attack upon earthworks.
3. The inefficiency of the ordinary shell and fuse as used during the last Russian war.
4. The destructive powers of incendiary shells when used against shipping, &c.
5. A method of preventing troops, &c. from crossing rivers by the aid of boats, pontoons, or other temporary bridges.

1. I must premise, before explaining my method of facilitating attacks by ships of war against *sea-face defences*, that the weakness of our navy was sufficiently demonstrated when the Allied Fleets openly went in and attacked the sea-face batteries of Sebastopol, and very soon withdrew out of range, only to renew partial attacks, either under the favouring cloud of a Black Sea fog or the darkness of a starless night.

This is *convincing proof* of the *inadequate power* of our navy in attacking such strongholds; it is *not*, therefore, by *increasing* the number of our steam-ships that foreign States can feel our supremacy on the seas, but by holding in hand an efficient "*incendiary steam naval brigade*," which would enable us during war effectually to destroy all their ships and colossal fortifications.

My method consists in attaching to our navy, as an auxiliary power of attack, an incendiary naval steam brigade, consisting of small and inexpensive steamers, having suitable iron compartments filled with my combustible compound, composed of prepared coal tar naptha, which can be easily obtained in any quantities, and at a trifling cost.

When sea-face batteries are to be attacked, the admiral commanding a fleet (choosing wind and weather), when nearly within range of the enemy's guns, starts one of the small brigade steamers, containing my inflammable material, having previously ignited a time fuse leading to a bursting charge; the steamer is then permitted to proceed towards the enemy's batteries, with her helm suitably adjusted. On exploding the bursting charge, the inflammable fluid is scattered on the surface of the water, causing its immediate ignition, and producing a *dense black suffocating smoke or vapour*, which, driven by the wind against the sea-faces, enters the embrasures, and either suffocates or drives away the enemy's gunners, leaving the forts in our possession.

By another mode of application, the admiral commanding the fleet could (choosing wind and weather) discharge a sufficient quantity of this fluid upon the surface of the water, allowing it to be propelled by the tide or wind up to the sea-faces of an enemy's batteries, and then cause its ignition by the projection of a shell or rocket containing naptha and potassium ; by the great affinity of the latter for oxygen, the floating liquid (which cannot mix with the water) will be immediately inflamed, producing a *dense black suffocating fog or vapour*, which envelopes the fort or battery, rushing into the casemates or embrasures, and which, driving away the gunners, would enable the attacking vessels (under cover of the black suffocating smoke) to approach the enemy's works and take up positions necessary for pouring in their broadsides, and thus to destroy the forts, unmolested by any hostile fire.

2. In facilitating attack upon earthworks, I have diaphragm shells filled with compositions which will burn as well in mud as in water, and, when a shell containing them bursts in mud or earthworks, the bursting of the charge ignites the inflammable material, and, the earth being porous and incombustible, prevents the combustion from spreading rapidly, but allows the *black vapour* to ooze out gradually, causing most serious annoyance to the enemy, who are utterly unable to extinguish the suffocating smoke, and are thus hindered from carrying on their operations.

3. With respect to the inefficiency of the ordinary shell and fuse as used during the last Russian war, it is well known that a heavy percentage of our shells, either burst in the air, falling short of the mark, or did not burst at all, owing to the shortness of the fusees, and often from their composition *not* being impervious to damp.

With respect to their destructive properties, it appears that in one week's bombardment, during the siege of Sebastopol, about 6,000 tons of shot and shell and from 1,500 to 1,600 tons of powder were used—yet no sensible impression was made on the Russian earthworks, for the damage done to them by the allied batteries during the day was generally repaired during the night by our energetic and gallant enemy, so that the Allies expended nearly all their shot and shell with comparatively trifling results.

It will be seen from the description I have already given at No. 2 that had diaphragm shells, filled with my compositions, been used during the siege against the enemy's earthworks, their destruction would have been certain, owing to the composition contained in those shells being ignited and absorbed by the porous and moist ground, out of which a black suffocating smoke would issue, thus preventing the enemy from extinguishing the same by any amount of water thrown over it, besides hindering them from repairing their works during the darkness of night.

4. The destructive powers of incendiary shells, when used against shipping, are fearful, as the inflammable material with which they are filled, being scattered in all directions (on explosion), would cause the destruction of any ships of the line on account of the impossibility of extinguishing it.

5. By my method of preventing troops, &c. from crossing rivers by the aid of boats, pontoons, or other temporary bridges, I allow the enemy to construct or place their bridge, or pontoons, and then permit any desired number to cross over, and, being thus divided, I cause a quantity of the material before described to flow into or upon the river, and among the pontoons.

The material or composition being ignited, the pontoons with the advancing troops are instantly surrounded with a devouring flame and a *black suffocating vapour*. Should there be a current in the river the material may be discharged accordingly, above or below the pontoon bridge, and allowed to float or drift thereto, and, when required, it can be inflamed by a shell, projectile, or other means best suitable.

The enemy thus become divided beyond all hope of reuniting, and the advanced portion being cut off from assistance or retreat, consequently falls into the hands of their opponents.

In the present "*reconstruction of the Navy*," no doubt the *number* of our *steam line-of-battle* and other ships of war will be increased, but augmenting their number merely adds to their power of *defence* and *attack* in *open sea*, as no increased efficiency in their powers of attack against "Sea-face Defences" is obtained.

We may have a splendid and costly steam fleet roaming up and down the English Channel. They may watch the opposite coast, and have an

eye on "*Cherbourg*"—that impregnable stronghold and safe anchoring-ground of the French Fleet; but should, unfortunately, at any time a war ensue, *dare they* even attempt to force an entrance within *that* harbour, when the garrison, unaided by their ships of war, can at any time concentrate a fire of *about two hundred guns* upon either entrance—sufficient, indeed, if well-directed, to sink the finest ships in the world?

I have already recalled to your recollection the fruitless endeavours of the *magnificent* allied steam fleets, when they *openly* attacked the *sea-face defences* of Sebastopol, and in thus bringing the subject to your notice I do not wish it to be supposed that I am in the slightest degree anxious to throw any blame on either commanders or men; but what I *most distinctly* desire to do is, to expose the *true weak side* of our navy, and to *propose* and *explain* an efficient remedy. By so doing, I conscientiously believe that more ultimate benefit will accrue to the national interests than by withholding information which I conceive is of such paramount importance.

Friday, March 4th, 1859.

COLONEL THE HONOURABLE J. LINDSAY, in the Chair.

METEOROLOGY.

BY REAR-ADMIRAL ROBERT FITZROY.

AN apology should be made for presuming to address you on a subject so familiar as that of wind and weather, even when dignified (I will not say mystified) by the term meteorology.

Yet acquainted as all are, more or less, with the causes and consequences of changes in the air we breathe, or in the water, which is scarcely less important to existence, it may be interesting, and one may hope useful, to endeavour to illustrate some of their remarkable features clearly and comprehensively. If they should be less philosophically treated than might be desired, I must hope that allowance will be made for a practical man, who has not graduated regularly in science, and therefore must be deficient in the higher acquirements. It is as a practical observer of nature, especially at sea, aided but little by books, that I now venture to ask for your attention to some few points in meteorology which may be so far popularised as to be useful in every-day life.

But what is the precise meaning of the term "meteorology?" a stranger may ask. "It is the science treating of air and water, wind and weather, heat, cold, and climate," may be replied.

As time is limited to the reasonable space of one hour (long enough to exhaust the patience of most hearers), I will premise briefly what is proposed to be submitted to you this day, and the subjects which are intended for notice next Friday.

First, I would endeavour to give a general view of the atmosphere, in order that the explanations subsequently offered may be properly understood, and then I will make very brief allusions to some of the most useful instruments, not going into or attempting anything like a complete description, to those who are more conversant than I am with most of them, but simply alluding to particular points in which certain instruments *now* adopted are supposed to be better than those which were used some years ago, and drawing attention to some of the novelties in them.

After having given this general reference to the instruments, I would try to show how they may be made most practically useful in every-day life, by foretelling weather, advantageously to the soldier, as well as the seaman and traveller, besides the farmer, the gardener, and the medical adviser. I would then very briefly glance at the ocean with reference particularly to the endeavours to explore its depths, because it is a matter of immediate interest—and if time should allow, I would refer briefly to the effects of changes in the atmosphere, and particular winds, on climates

generally; but this, probably, must be put off till next week, when what is commonly called "cyclonology," or the investigation of circular storms, in connection with the general winds, and the movements of the atmosphere, called sometimes (whether correctly or not) "atmospheric waves," a much-disputed question intimately connected with the barometer, will be considered. These being rather more scientific, may be deferred at present.

Speaking now of the nature of our atmosphere:—It is very commonly remarked that air is a fluid, and that all fluids are much alike. Air is a fluid, water is a fluid, gases are fluids. Very true—but there are these remarkable differences between the fluid, *water*, and the fluid, *air*. Water is almost incompressible and inelastic. It is composed of two gases, which are mixed together *chemically*, oxygen and hydrogen—the water, not being elastic, exerting no force to spread itself, except in common with other fluids by seeking its own level, with reference to the centre of the earth (or gravitating towards the centre of the earth). All fluids have that property in common, they all gravitate and seek to attain a uniform level. But air has the peculiarity of extreme elasticity. It is not only fluid as water is fluid, and therefore seeking to maintain its equilibrium (with reference to the centre of the earth), but it is always more or less under *pressure*, and if that pressure be relaxed, ever so little, it expands immediately. It has a constant tendency to *expand* in every direction. Water only spreads.

About 15 lbs (everyone knows) is the weight of the atmosphere pressing upon every square inch of surface at the level of the ocean. This pressure may be relaxed, locally and temporarily, by air being withdrawn, or lightened by heat around the locality, by being rarefied above it, when immediately the air around expands, seeking to fill up the space of lessened pressure. If you draw a part of the air out of a room, the rest of the air in that room will fill the remaining space, as air is capable of very great expansion. I do not know whether ascertained, but believe it is nearly indefinite. Why I would lay stress upon this point now is, because it immediately affects the barometer.

But this is not the only reason why, when air becomes more expanded and lighter, the barometer, which weighs the air, sinks, but also from the watery vapour, invisible, but in the air itself, as *gas*, expanding by heat and occuping more space.

By the expansion of this gas, air becomes lighter; and, bulk for bulk, a given space full of warm air with expanded watery gas (or aqueous vapour) is lighter than an equal bulk of dry air. This is another reason for the mercury in the column of the barometer falling in certain states of the weather, and rising in others. Upon this question, however, there has been much difference of opinion. Some authorities demur, and assign other causes. Some indeed think that the effect on the barometer is chiefly caused by *electrical* changes; but, while we *have* simple and general causes intelligible to all, and which we know, from experiments easily made, do take effect, I do not see why we should look only to the mysterious workings of electricity, although its (secondary) results are occasionally remarkable.

The effect of the atmosphere upon the thermometer—the ordinary

motion of the column of mercury in the thermometer—everyone notices almost daily.

The barometer is used not only for the common purposes of a "weather-glass," but as a scientific instrument, and for measuring heights. I refer also now to the use of the "*boiling point thermometer*," to show the little reliance that can be placed upon this instrument, as compared with the barometer, for measuring great heights; and I mention it particularly, because within the last few years much stress has been laid upon the measurement of some very remarkable mountains by boiling water. Each degree of the thermometer is equivalent to about 550 *feet of ascent*, or one-tenth to 55 feet; therefore, the smallest error in the graduation of the thermometer itself will affect the height deduced materially.

In a thermometer which is graduated from 212°, the boiling-point, to 180°, similarly to those intended for the purpose of measuring heights, there must have been a starting-point, or zero, from which to begin the graduation. I have asked an optician in London how he fixed that zero, the boiling-point: "By boiling water at my house," he replied. "Where is your house?" In such a part of the town, he answered. I said, "What height is it above the sea?" to which he replied, "I do not know;" and when I asked him the state of the barometer when he boiled the water, whether the mercury was high or low, he said that he had not looked at it! Now, as this instrument is intended to measure heights and to decide differences of some hundred, if not thousand, feet upwards, at least one should endeavour to ascertain a reliable starting point. From inquiries which I have made, I believe that the determination of the boiling-point of ordinary thermometers is at present very vague, not only from the extreme difficulties of the process itself, (which are well known to opticians,) but from the radical errors of not allowing for the pressure of the atmosphere at the time of graduation—which may be much, even an inch higher or lower than the mean, or any *given height*, while the elevation of the place above the level of the sea is also unnoticed. Then there is another source of error, a minor one perhaps: the inner limit, the 180° point, is fixed only by arbitrary measurement, by comparison with another thermometer; it may be right or it may be very much out, as may be the intermediate divisions, for the difficulty of ascertaining degree by degree is very great; and it must be remembered that the measurement of a very high mountain depends upon those inner degrees from 200° down to 180°, and thereabouts. Hence the difficulty of fixing them upon the thermometric scale, and of making a reliable observation by boiling water, may be greater than has been generally supposed and admitted.

By one of the boiling-point thermometers to which I referred, may be seen at once how very small the degrees in the small space ranging from 180° to 212° must be, while even their starting point is not reliably fixed.

There is an application of the thermometer which would be used advantageously and frequently, if more generally known. I mean the common moistened or wet bulb thermometer, used with a dry one as a "Mason's" hygrometer. One thermometer being moistened, is kept cool by evaporation and shows its temperature. The two thermometers need

not be placed quite together. You may hang either in one place and the other pretty near it, but not close, provided that they are under the same conditions, or in similar circumstances. The bulb of one should be kept moist, (not wet, but simply moist,) so that evaporation may go on, and then that thermometer will show the temperature at which water is taken up and converted into invisible vapour; while the other will show the temperature of the air. The difference between the two, doubled and taken from the lower, shows very nearly the "dew-point;" or that at which dew is formed (as on a bottle of water brought out of a cold place, when, according to the lower temperature of the water within, the deposition will take place, sooner or later, by the vapour in the air beginning to be condensed into moisture). Hence you may know whether the air is more or less moist, whether rain is likely to fall or not, or whether your room is too dry or too moist. It is a very simple instrument, and, if more freely used, might become very much more popular. At present it is generally thought rather too scientific, and so much notice is not taken of it as should be. In connection with the barometer, it affords an almost unfailing warning of the weather that is coming on, as I will show subsequently.

The Kew marine barometers, which are now much used in the navy, and frequently in the merchant service, are made of glass, iron, and brass. The old barometers used to be generally cased in wood, and had wooden cisterns with leather bags. It is supposed that a metal barometer, with a glass tube securely fixed in it, can be graduated with greater accuracy, and is more reliable in its indications, than a glass tube in a wooden case. The French, however, have been hitherto of a different opinion, and use the wooden case: but they are now instituting investigations, with a view of proving the question. The English opinion has been that wood, being hygrometric, alters its length, and therefore the graduations are liable to be incorrect. That is one disputed point. Then the method of securing the tube in the cistern is said to be more manageable in wood. The English opticians, however, who probably have more experience on their side, say that it cannot be well and permanently fixed in wood, because climate, moisture, heat, and cold alter the casing, the cistern, and the leather, so much that the instrument becomes deteriorated, and lets in air, while the position of the tube is more or less altered. In an iron cistern the tube is securely fixed, so that it cannot vary upwards or downwards. Some think it is too securely fixed, and therefore it is liable to be broken by concussion more readily than that of an inferior instrument. This, however, appears to be a necessary consequence of greater exactness, and if exactness is requisite the tube must be fixed securely. It is not generally known that this instrument is not graduated to exact inches; the inches are artificial, and so spaced as to show the correct height of the column (compared with a standard barometer, by trial and error), so that after the instrument has been graduated and thoroughly verified by the proper process, there are no corrections requisite to be applied to it except one constant, for scale or index error, and one varying, for temperature. None of the corrections depending upon the size of the tube and the relative size of the cistern, and for capillarity, which are necessary in some land standard barometers, are required in these,

which, after being verified in a reliable observatory, such as that at Kew (established by the British Association for the Advancement of Science), become valuable as standards.

It may not be generally known that the only difference between such a barometer, and a barometer used on land, is that the upper part of the tube is alone carefully measured (or calibrated, as it is termed). Upon the nicety of that part of the tube the value of the instrument chiefly depends; the size of the other part is of little moment, for whether the interior bore is greater or less, makes very little sensible difference to a barometer made upon the Kew principle. Whatever constant errors exist, are proved by actual "trial and error," and allowed for in the graduation, which, as I said before, is *artificial*. The part of the tube contracted to prevent the mercury from "pumping" (or oscillating with the motion of the ship) may be 2 or 3 inches long, or it may extend the whole length. In most of the old marine barometers, the contracted part extends the whole length, but in this one it is only about 2 inches. Below this there is a "pipette," or a little funnel with the point downwards within the tube. The air, which may work its way in, never goes *through* the mercury; it always passes between the mercury and the glass, so, by having this funnel within or near the top of the tube, any air which goes up by the side is stopped at the shoulder and there remains; the mercury itself working up and down through the middle of the funnel. After a barometer has been some time in use, if any air has got into this part of the tube (and it cannot get beyond, or into the upper part, when it is thus constructed), or when there is reason to suppose that air has got into this part, you have only to turn the lower end of the tube upwards and tap it gently, when all the air will gradually go out, and pass into the cistern again, the barometer tube thus becoming freed from it.

During four years that the office has been established in which I am employed, such instruments have been sent out, and returned from voyages on board merchant ships, as well as men-of-war, sometimes for two or three voyages successively, and most of them without injury. In the first two years several were broken; but chiefly, I may say, through unduly rough usage, several being from the near concussion of guns on board men-of-war. In one instance the barometer was hung immediately under a heavy pivot-gun, which was fired just over it, when, of course, such an instrument could not stand the shock. Others were placed between decks where men in exercising ran against them, and it thus happened that many were returned "broken," from men-of-war, during the first two years. During the last two years, however, there have been very few breakages; while from merchant ships during the four years, not 5 per cent. of the whole number afloat, out of several hundreds that have been supplied, have been broken; so that as far as experience has gone, they have stood common work very well. They have been sent by railroad, in a manner which the old-pattern barometers could not have borne, and have preserved their merits. Not only is the cistern itself a fixture, as it were, requiring no opening and no adjusting, but the little funnel within the tube prevents the air from getting into the part of the tube upon which accuracy depends. Within even the last month, I

have had the testimony of other authorities, in addition to that of the Astronomer Royal for Scotland, to the effect that these barometers are equal to any work for which standards are required on land or at sea.

Still I think another kind of barometer might be found better for men-of-war, with reference to the concussion of guns—that it might be made upon the syphon principle, and graduated on the glass itself.

The tube of a Gay Lussac mountain barometer is on the syphon principle; there being no air in the long tube, the mercury falls to a certain distance when the short tube, which corresponds to a cistern, is open. When this short tube, or leg, is opened, the mercury rises to a certain point according to the atmospheric pressure, just as in the cistern and column mercury acts in other barometers. The scales slide, and you measure from the level of the mercury in the long tube to that of the mercury in the other, so that all errors, excepting those caused by temperature or a defective graduation of the scale, are obviated. It is the simplest of all barometers in principle, but difficult to deal with at present, because the mechanical construction is critical. It is rather curious that these instruments, perhaps the best mountain barometers of the present day, are now made in England by a person who is employed by the principal opticians, while he is ostensibly keeping a hotel not many miles from London, though the sole maker in this country, who is now reliable.

These Gay Lussac barometers have been taken to many parts of the world, and have been found to answer exceedingly well, when duly cared for. Some however say they are too brittle, and cannot easily be carried by travellers.

My principal object in referring to them was to show that I thought a barometer upon nearly such a principle, with a very strong and graduated tube, might be made available for men-of-war, which require a barometer far stronger and less brittle than any of the instruments that are now in use. When Sir John Richardson went on his land journey to the Arctic regions, he wished to take a barometer that would bear rough usage in travelling, and he had one made on his own plan. It went with him and came back uninjured. He had some spare tubes. It was very strong, and would not run any risk unless hit very hard. It is graduated upon the tube itself, which is an eighth of an inch in thickness, and will stand rough usage. The tube has an iron screw securely fixed upon it, which goes into the cistern. The cistern can be carried in one place and the tube in another: the tube being in a wooden case by itself, and therefore not liable to be broken by having the weight of any mercury in it. The filling it properly, requires a long elastic tube or funnel to go down to the bottom of the glass tube, through which the mercury may be poured in carefully, beginning at the bottom, so that as it fills the tube it forces the air out before it. You fill it quite full, with the cistern screwed on and held up; then screw up, by the bottom screw—reverse, and take out the little screw, through the hole for which a certain quantity of mercury may be withdrawn by a small syphon till the mercury's level is at the *marked* neutral (or starting) point. With a little syphon made of glass, or wood (on the principle of that which is put into a cask), as much of the mercury as you choose may be withdrawn: or, the

tube may be screwed more or less into the cistern, till the mercury is exactly at the mark. I do not say that a barometer thus roughly constructed (with *unboiled* mercury) can be compared with the accuracy of a more scientifically constructed instrument, such as our first opticians would make; but I believe that it would be very much more reliable for travellers (within certain limits of error) than boiling water thermometers, or Gay Lussac barometers, or any other means that we have at present, because it is strong, it is very portable, the limits of error are known, and they are not too great for use. I believe that one would get the actual pressure of the atmosphere anywhere within *two-tenths of an inch;* which, when measuring a mountain from 12,000 to 20,000 feet in height, would correspond to but a small quantity, namely, about 200 feet of altitude, a difference much less than the uncertainty of corrections necessary for temperature, and other circumstances, at a great elevation. The instrument before you is the identical one which Sir John Richardson travelled with and brought back uninjured.

Merchant ships which have been supplied by the Government with instruments during the last three or four years, and many men-of-war that have been supplied, had at first thermometers with metallic scales, which came back after a voyage in a rusted and illegible state. To obviate that a white porcelain scale was brought into use, which answers remarkably well. It is made like a plate, the scale being baked with the *larger* figures on it, the maker's name, and all that can be placed, without extreme accuracy being required, before graduation. The exact marks for the graduation of the scale are then cut in, or etched, and the marks blackened with nitrate of silver or some other chemical preparation. Thus, the scale not being put into the fire again after graduation, these thermometers remain without change of form, size, or colour. They can be easily read at night, and are perhaps the most useful that have been made.

Another kind was previously tried, namely, slate: but was found to be too easily defaced, and on the whole it does not answer so well as porcelain or earthenware, neither is it so easy to read at night; porcelain is altogether preferable.

Some thermometers, merely for scientific investigation, have a blackened bulb, and, if *in vacuo*, the air is exhausted out of a glass globe which incloses the bulb. The sun's rays striking upon such a blackened bulb, in the focus of a reflector, cause the greatest degree of heat at the time and place. It is for trying experiments in various climates with a view of ascertaining the intensity of the sun's heat under various circumstances, and is a contrivance that has only been effectually completed within the last few months.

Various anemometers, wind-gauges or wind-measurers, have been brought into use lately, and within the last few days two such instruments, on the most approved principles, have been sent out to Halifax and Bermuda by the Government (one by the Board of Trade and the other by the Admiralty). The principle upon which those anemometers measure the wind can be shown by a little instrument (intended for use on board ship) mounted on gimbals like a compass, in order that it may remain horizontal under any motion of the ship. It was found by Dr. Robinson

(of Armagh) that the shape of a hemispherical cup (exactly the half of a sphere) offered a third greater proportion of resistance to the wind on the concave side than on the convex side, and that the velocity of such cups, when put in motion by the wind, is one-third that of the wind, nearly, the wind exerting a third greater force upon the hollow side than it does upon the convex side.* This fact being known, the measurement of the velocity and force of the wind is comparatively easy. The proportion is not quite exactly three to one, but very nearly so. Such an instrument may have a self-registering apparatus with clockwork or dials, like those of a gas meter, to register the velocity of the wind in a certain time; the force may be ascertained by comparison with a pressure-plate, or by calculation. The instruments that are sent out to Halifax and Bermuda upon the same principle are large and self-registering. There is an apparatus attached to them of wheels and rollers, with paper fixed on the rollers, so that in whatever way these cups move their indications are registered by the machinery below, connected with a clockwork moving cylinder covered with paper, and a pencil making the indications. All is so well contrived, that it is only necessary to look at and change the paper once a day (Osler's and Robinson's principles combined).

An attempt has been made to obtain a hand instrument, which is much wanted. At present the measurements of wind on board ship are merely estimated. Lind's wind-gauge, modified by Sir William Snow Harris, and altered subsequently, may yet effect the object in view, which is to get an instrument that you can hold up to the wind. A level which it has, shows when it is exactly horizontal; and the means of opening while holding it to the wind, and shutting it instantly at pleasure, are effected by a touch. It is Lind's wind-gauge, with a means of opening and shutting the orifices. The wind blows in, pressing the fluid to a certain distance along the graduated tube according to its strength; your thumb at the back keeps the instrument open till you choose to shut it, when you may read off. It is not perfect, but I believe it will be a tolerable approximation to a wind-measurer. The level is on the principle of the very simple "Peruvian level," that by which aqueducts in Peru and Mexico were carried out, namely, a hollow cane or bamboo half full of water with an opening and a float near each end, the floats carrying marks of an equal height, and the cane being placed so that the observer's eye might be in a line with those two marks (just as the eye should be in a line with the sights on a gun). When the two points are in one line with the eye the level line is shown. The late Sir Francis Beaufort was exceedingly anxious for some instrument of this kind. His scale, a very good one for merely *estimating* the force of the wind, became generally adopted, not only in this country but in America and France, yet he wanted something of this kind to verify and use with it. I do not say that the gauge described will quite answer our purpose, but something of the sort may give means of actual approximate measurement, instead of arbitrary estimation.

The atmosphere consists of very minute particles, far smaller than can

* The effect of friction is not considered, because, when well mounted and furnished with friction balls (rollers), there is in effect no sensible amount of retardation due to friction.

be shown by measurement, or that we can realize to our conception. A glass containing very small shot (dust shot), compared with another glass containing large shot, may help to illustrate what I mean when saying that different gases—the different component parts of the atmosphere—may differ very much in their mechanical nature, as to their particles (smaller or larger); and that the particles of one kind may mix among those of the other, between their interstices, while another substance, such as perhaps heat, may mingle with those various particles, as water mingles in such glasses with shot. A good deal of water can be mixed with such shot before all the interstices are filled—and so it is in the case of particles of atmosphere. I refer to this as a practical illustration of one gas mixing with another, and of vapour or heat being spread through a portion of air, without increasing its apparent bulk, being sensible to the eye, or the contrary.

Supposing that the air over any place at which the atmosphere is lightened or rarefied, by heat insinuating itself between the particles of air, they are expanded, become lighter, and occupy greater bulk, therefore equal cubes weigh or press less. A body of air then ascends; and it acquires a certain momentum which carries it on; but, having left a particular place, other air *must* come into that place, which cannot be a vacuum. Being raised by its comparative lightness, it ascends, and other air pushes in immediately from all space around to fill its place. In a room, for instance, rarefied air goes up towards the upper part, and cold air comes in from below, if there is an opening for supply.

Upon this simple general principle, the principal phenomena of wind in our atmosphere depend chiefly, I will not say entirely, because there are local, temporary, chemical, and electrical causes; but the great principle upon which the movements of the atmosphere generally depend are simply these: the rarefaction and rising of a body of air, the place of which is filled by other air coming in from the readiest source of supply.

Supposing that a diagram represents the world's surface from one pole to the equator and the other pole (a section through the globe from pole to pole); if the air is rarefied at the equator, and ascends in a body, we have shown that other air must rush in to supply its place. The trade winds continually blow towards the equator; the heated air thereabouts cannot go up beyond a certain distance, where it becomes cool, and is prevented by gravitation from going beyond a certain distance from the earth's surface. It can only go laterally. Pressed upon still by air rising from below, and by the constant * pushing in of other air, it flows over laterally, and makes its way *towards* the poles; but before it has passed beyond the tropics, there is a demand for it below, or underneath, from the places it is passing over (in about the northern extremity of the tropics, from 25° to 30°); and if the supply is at any time failing from the poles, the cooling and sinking of the air about that part (30°) will tend to supply the want at the equator: thus there will be (what I will another day endeavour to explain more distinctly) a double action; there will be a pressure downwards of the upper returning current, which has been cooled and dried to a certain extent, on its way to the pole, a pressure of this returning current about the latitude of 30°, and a pressure at the same time from the polar regions, which are generally supplying

* Vis a tergo.

the want caused by the sun's heat rarefying and making the air ascend at the equator.

This double, or concurrent, action is probably a chief cause of the constant accumulation of air, and a greater pressure of atmosphere about the (so called) "horse latitudes," near 30°, where the barometer all the year round stands higher than anywhere else in the world, on an average, if not in extreme cases. I allude to this with a view of showing how the simple principle of the rarefied air ascending, and its place being supplied by colder air, is carried out in the movements of winds, by supply from the colder places, or poles, and the upper currents of returning air. No air can escape from the attraction of the earth; it cannot go beyond a certain distance. Whether our atmospheric air extends further than ten or twenty miles can only be conjecture; perhaps beyond that distance there may be far lighter gas than our own mixed air; there may be much hydrogen, which is the lightest of all gases; but no experiments that have yet been made have proved with certainty what are the constituent parts of our atmosphere beyond five or six miles upwards.

I may here, with reference to some intended observations, allude in the same brief way to the combined action of the earth's rotation with the circulation of the atmosphere. As any body of air which we suppose to start from the equator is making its way northward, whether stopped at the latitude 30°, or carried on to nearer the pole, the earth itself is turning; and the consequence of these combined actions is, that instead of that body of air going direct towards the pole, as the earth turns, this said mass of air, having the velocity of the equatorial part of the earth (not of the polar part, which turns very slowly), moves eastward as it goes northward, and its actual course is towards the north-east.

On the other hand, the cold air from the pole, which starts southerly, meeting parts of the earth that are turning faster and faster, comparatively, is left more and more behind, and becomes while going towards south and west, north-easterly and easterly in effect. There can be no doubt (on the authority of Herschel and Dové, the two first meteorologists,) that such is the system of our winds, and that if referred to when using instruments shewing the pressure, direction, elasticity, and composition of the air, the facility with which nearly all that takes place in the atmosphere can be foretold or explained becomes satisfactory beyond expectation.

One subject, that of clouds, may be only briefly referred to now, as there will not be time for more. A cloud is formed before you, or what may be called and is a cloud, when an urn is smoking or rather steaming on the breakfast table. Steam which ascends from the urn is at first, when it is close to the urn, invisible; but it spreads, becomes visible, and then is dissipated altogether, if not condensed on a cold substance. A cloud is watery vapour, in a state *between* invisibility and water. Perfect gas or pure steam is not visible: what we generally call steam is that same vapour slightly affected by the chill of the atmosphere, or partly turned to a cloud. Steam, when unaffected by external air or cold, is quite transparent. Directly steam expands into air, it is more or less chilled, and the first effect is an appearance of cloud; but as soon as the particles can diffuse themselves, among *comparatively* dry air, the aqueous vapour is taken up, and you see no more of it. The large clouds we see in the

air are comparatively near the earth, which is always much warmer than the air high above. A certain quantity of water can be held in suspension in an invisible condition within a given distance of the earth—that distance frequently varying according to the changes of temperature. A certain chill brings it down, perhaps at once, in rain, but between the state of rain, the actual deposition of moisture, and invisible vapour, there is that state which takes place when vapour is only chilled, as seen in clouds. A considerable amount of cold acting upon aqueous vapour existing in an invisible state in the atmosphere turns it into water, condenses it, and then down it comes as rain. If there is not a great amount of moisture, and if it is simply chilled, it becomes like mist or fog. It does not fall in rain, but is like the mist which you see rising from boiling water.

If you go into a laundry when there is much washing going on, you probably find the whole of the upper part of the room full of steam. That steam is cloud, which cannot get away—being confined in the room; if it could get away into the air it would be taken up by the drier air and apparently dissipated, just as a sponge takes up a certain quantity of moisture. The air is generally in a state that will enable it to take up a certain quantity of moisture (more or less according to temperature and other conditions); but as aqueous vapour in the air is invisible under ordinary circumstances, and when condensed by sufficient cold becomes rain, there must be immediate states between the two, which intermediate states are the varying conditions of clouds which we see above our heads, in every condition and form.

Fog and the cloudiness in a room full of steam are similar varieties of aqueous vapour.

Many gentlemen in this room have ascended high mountains and passed through clouds. They found that the clouds, when they were in them, were just like fog, that they got above, and completely out of them, and that the chilly air alone seemed to keep vapours in a visible state.

This appears to be a simple explanation of appearances which some have connected entirely with electricity, and have tried to explain more elaborately; but it has been generally found that nature's works on the greatest scale are precisely similar to her operations on the smallest, and that, what is true of water or vapour of any kind, in a small room, is, if the right principle be fairly carried out, true of all the operations of nature respecting aqueous vapour and water on the largest scale in the universe.

I must refrain from further occupying your time now. The subject is one upon which there is inducement to enlarge. Another day I will endeavour to refer more clearly to these subjects in immediate connection with Dové's "Law of Gyration," or rotation theory, and the (so-called) atmospheric waves.

One may call a simple diagram, a circle divided by a diameter from north-east to south-west, the thermometer compass. While the wind is shifting from south-west, by west, north-west, and north to north-east, the thermometer is falling, but while shifting from north-east, by east, south-east and south, towards south and south-west, the thermometer is rising. Now the barometric column does just the reverse. From north-east the barometer falls as the wind shifts through the east to south-east, south,

and south-west, and from the south-west, as the wind shifts round northward to north-east, the barometer rises—it rises to west, north-west, north and north-east.

The effect of the wind thus shifting round and traced upon paper by a curve seems certainly wave-like to the eye; but I believe it to be simply consequent on the wind shifting round the compass, and indicating alteration in the barometric column.

If the wind remained north-east, say three weeks, there would be no wave at all—there would be almost a straight line along a diagram (varying only a little for *strength*). The atmospheric line, in such a case, remains at the same height, and the barometer remains at 30 inches and (say) some three or four tenths, for weeks together. So likewise when the wind is south-westerly a long time, or near that point, the atmospheric line remains *low*, towards 29 inches. It is thought heterodox to say, *now*, that "atmospheric waves" are an optical delusion; but—as generally understood, such a misconception is asserted.

Such a diagram as alluded to above shows how the barometer and thermometer may be used in connection with each other in foretelling wind and consequently weather that is coming on, because as the one rises the other generally falls, and if you take the two together and confront with their indications the amount of moisture in the air, at any time, you will scarcely be mistaken in knowing what kind of weather you are likely to have for the next two or three days, which for the gardener, the farmer, the soldier, the sailor, and the traveller, must be frequently of considerable importance.

Among the objects to which meteorologists should chiefly devote themselves seems to be the selection of practically and immediately useful points, in the first instance, and purely scientific ones, for future objects subsequently. Among those most useful, probably simultaneous observations, once or twice in the 24 hours, by general concert of a great number of observers, will be found the most immediately available, because they give a bird's-eye view of the world's surface at a given time, and again synoptically for successive definite times, days, or weeks, perhaps months, from which may be learned what is the regular or irregular succession of weather, what may be expected, and what are the various causes and connected circumstances. Such a plan is now in progress, and we may hope in two or three years to know, at all events in the Atlantic, and the countries bordering on this nearest ocean, what is the usual course of changes and *sequences* of weather during certain cycles—to know beforehand what may be expected, and what changes certain occurrences will inevitably bring after them, so as to become enabled to turn such warning knowledge to practical general use.

CHAIRMAN.—I am sure every one who has heard Admiral FitzRoy's exposition of the subject must be deeply impressed with the ability which he has brought to bear upon it, and also the extreme clearness with which he has put the subject before us. When an officer whose time is fully occupied and deeply engaged in the public service (as Admiral FitzRoy's is) favours us, as he has done to day, our thanks may well be in proportion to his devotion to our service. I may offer him also, at the same time, the thanks of the COUNCIL of the Institution for occupying so much of his time in explaining the subject.

Friday, March 11th, 1859.

REAR-ADMIRAL SIR GEORGE BACK, D.C.L., F.R.S., in the Chair.

I will endeavour now to explain some of the principal and general movements of our atmosphere,—looking at the world as a whole, and referring to generally prevalent movements, not to merely local peculiarities.

Pray suppose that you are looking at a section of a globe from pole to pole as if looking at our world from a position at some distance outside of it, and taking in the view of a whole hemisphere, and then remember that the effect of the sun's heat, the constant effect throughout the year, is to warm and elevate, or *continue* raising all the body of air in the neighbourhood of the equator from many degrees, say ten or twenty, on one side to many (perhaps more) on the other.

Around the whole circumference of the world it is that zone of the atmosphere upon which the sun exerts the greatest and most constant power, the effect being to keep the air in that particular region continually rising. But it cannot rise beyond a certain distance, because the counter effect of gravitation towards the earth's centre acts. It also gets chilled and cold, after rising some miles from the earth's surface; but being continually pressed upon from below, by air still more recently heated, the upper air must flow away *laterally* (like water seeking its level) in the higher regions of the atmosphere, where it may be said to overflow. Meanwhile, to the lowest spaces adjacent to the ocean or land whence such air has risen, other air will press in from either side to fill what would otherwise be a comparative vacancy; such other air being cooler, and drawn from afar, whether from south or north, or elsewhere. Now that air which has been first warmed, expanded and raised,—then cooled in the upper regions—must go somewhere. It cannot go upwards beyond a certain limit. The consequence then is that it overflows, as has been shown, on each side, part going northward in a direction nearly corresponding with the shape of the earth's surface, or parallel with it; part going similarly towards the south—thus keeping up a continual movement of air towards the poles, *from all parts of the equator, all round the world*, while there is another tendency constantly of the lower air, from the poles towards the equator, *near the earth*. A grand and immediate effect of these constant currents, or as one may say of this circulation, is the phenomenon of the trade and (so-called) anti-trade winds prevailing within certain limits, the former from near the equator to 20 or 30 degrees on each side of it, all round the world, and the latter in middle latitudes, excepting where spaces of land intervene and, from their heat or cold, occasion local or exceptional differences. Speaking *generally*, these trade and anti-trade winds around the world, upon which navigators depend so much, are caused by ascension of the equatorial air, and a supply of its place by other air pressing towards the equatorial places of departure.

Now that cold air (cooler air) flowing in, must of course come from some great source of supply! *Where* is that source of supply, one may ask, in sufficient quantity? If you compare the size of the world in its equatorial regions, the bulk of it around the equator, with the *small area* near each pole, and consider that the world is constantly turning, the central part being very large and moving rapidly in proportion to the polar, where it has very slow motion, it will appear evident that the mass of heated and expanded air near the equator must be very much larger than the body of air near the poles. It is not only very much larger in quantity, but it has a rotatory motion, very rapid, nearly equal to that of the equatorial earth, which air near the poles has not. The nearer the pole the less the rotatory movement of the earth, the nearer the equator the more rapid that movement; and the atmosphere, which goes nearly with the earth, moves similarly. The result of these combined movements, those of the earth and air, is that warm air which moves towards the pole from the central zone has another impetus, with the velocity of the equatorial regions, and as it goes towards the pole while the *earth turns eastward*, moves faster and faster than the earth does as the polar regions are approached. If you throw anything out of the window of a railway carriage in motion, it partakes of your motion, and instead of dropping behind, it drops abreast of the carriage. So with air that rises from near the equator in its movement towards the poles; and the consequence is, such a prevalence of westerly winds in middle latitudes, that they are justly termed anti-trades. These prevalent winds are at first south-westerly, then westerly or north-westerly in the regions between the tropics and those of the arctic and antarctic circles.

The converse action, which is the easier to understand at first sight, takes place from the pole towards the equator. The mass or body of air or wind, starting from near the pole, moves towards the equator with little or no circular or rotatory movement, because the body of air within the arctic regions is *comparatively* slow in rotation, that part of the earth moving very slowly compared with the equator. Any body of air from polar regions then moves towards equatorial parts to fill the spaces being continually vacated there; but as it so moves the earth is turning to the eastward and the result is a diagonal, a more or less diagonal movement of any such body of air across the world's surface, causing north-north-east or south-south-east, or north-easterly or south-easterly, or easterly winds; *more* easterly as you get nearer the equator; so that the wind which we feel here as a north-east wind actually left the arctic region as a northerly wind, and, probably, when it has passed further south, will become sensibly more easterly. The simple effect of the polar current becoming more easterly towards the equator may be shown easily by moving a pencil from either pole of a common globe, on a stand, towards the equator direct, while the globe is turned eastward. The line traced by hand makes a diagonal (or rather a spiral) line nearly between the two directions. (It is spiral on account of the globular form.) This effect is easy to see; but the other movement, from west to east, and the reason why a body of air moving from the equator towards the pole goes faster than the surface of the earth over which it moves, is not so evident *at first*. It is only after reflection one sees

clearly that, the rotatory movement within some degrees of the pole being slow—compared with the rapid motion near the equator—if the air rising from the equator moves with the momentum of that part of the world, as it goes further towards the pole it must move faster and faster over the earth's surface in an *easterly* direction, and the result must be the general or prevalent westerly winds in middle latitudes, which have been lately and justly called by Sir John Herschel and others, the anti-trades.

Referring again to a globe, its poles and equator, we see that extensive central masses of air rise from equatorial regions, move *above* laterally and towards the poles, and that polar currents move nearer the earth's surface towards the equator. Owing to the convergence of the meridians (that is, their approaching nearer and nearer), all the meridians meeting at the pole, from larger spaces at and near the equator, the polar supplies are deficient, and are made up for by parts of the equatorial current, as will be shown. All the body of air round the equatorial region, large and expanded as it is, has a *tendency* to move towards the poles; but it *cannot do so*, there is not *space* enough for it; the law of gravitation acting through this fluid air, seeking its equilibrium, prevents its *rising* beyond a limit; when resisted and cooled it becomes compressed, and then struggles with the polar counter-current for room near the earth's surface. Suppose that a body of air at the equator (which has the above described double tendency, namely, to move eastward and towards the pole), starts from an equatorial place, and moves more and more westerly (from the westward) over the earth's surface as it goes towards the pole, because its motion in middle latitude is faster than the motion of that part of the earth from the west, and it goes, therefore, faster than the earth,—it becomes compressed into smaller space, and also—meets with the polar current making its way towards the equator,—by the turning of the world making a diagonal (or spiral) course which is north-easterly, and afterwards easterly when it gets near the equator. There are thus two conflicting currents or bodies of air, one making its way northward and becoming compressed, having its vapour condensed and (as it were) squeezed out of it by the dry polar current which it meets, and the other making its way towards the equator. The effect of the antagonistic currents of air in raising the barometer about the "horse latitudes," and the return of part of the upper current, when cooled and condensed, to the equatorial regions, has been already described in the first paper. We see the effects of these two conflicting currents in ordinary changes of weather in this country (nowhere more plainly) the wind continually going round by north, east, south, west, and north—round and round again in successive changes, comparatively seldom going round the other way, the retrograde motion being exceptional to the *general* rule, like the exceptional eddies which one may see in the currents of a river when streams are meeting one another, the eddies generally turning one way, but occasionally from some local circumstances, turning contrariwise, as exceptions to the general rule of direct change, which is as the hands of a watch move.

Perhaps these views are not easy to make quite evident at first, more particularly that part relative to the equatorial or heated current going

faster than the world, and therefore making westerly winds as it gets toward the pole; but it is the explanation given by Herschel and Dové. Dové bases upon it what he calls the "Law of Gyration," and to him is due the credit of having proved, if not detected, this law, by comparing most perseveringly, during the last thirty years, observations from all parts of the world; and he has shown that this law of gyration applies equally to all parts of the world; that it is not peculiar to the Atlantic or the Pacific, or north or south latitudes, but it is the general law throughout the world, exceptions occurring only over or near countries which are covered with snow or ice, or are localities where the sun's rays strike periodically and cause great heat. Such local circumstances interfere with the regular or normal movements of the winds.

From the "Law of Gyration," it is easy to trace the contests and effect of the two principal winds, which are quite different in their character, the one being warm and moist, having a great deal of watery vapour held in it as gas in an *invisible* state. Sometimes this vapour will be chilled or cooled by approach to the polar current near it; perhaps above, perhaps on one side, causing the vapour to become visible in the shape of cloud, or, when more cooled, precipitating it as rain; at other times, it is invisibly retained in the atmosphere.

Everybody may have noticed, when the wind has shifted from south-west to west or north-west, particularly during bad weather, that the first shift to the northward, or from the south even towards the west, is generally accompanied by a sharp squall, a good deal of rain, and perhaps hail, after which the weather clears up. This is the usual course in our latitude.

The circulation of atmospherical currents need not be only horizontal—it may be at an angle with the earth's surface—or even vertical; but the first effect of any cold current impinging upon the warm equatorial, is to cause condensation of its vapours in the shape of cloud, if not rain, hail, or snow. After this first effect, being dry (comparatively), it acts like a sponge; it takes up the rest of the vapour that there may be in the air. There is no longer precipitation, but all the vapour that it can sponge up (as it were) goes away invisibly; and after a short time, there is a clear sky with a polar wind.

Thus, the first effect of the cold air is condensation, and the subsequent effect of the dryness of the air is the sponging up and hiding the vapour (as it were) in itself: dry air from the polar regions being capable of containing a great deal more vapour in an invisible state than the warm air which comes loaded with aqueous vapour from the equatorial regions—loaded, indeed, with nearly as much as it can carry.

The struggle between these currents over various parts of the earth's surface, occasionally causes the circular storms, now usually known by the term Cyclones, or rotatory gales.

Whether so called or named typhoons, tornadoes, hurricanes, or whirlwinds, circular or rotatory, more or less, they all are, not exactly, but in an elliptically curved form, more or less irregular rather than circular. The outline of such a circulation of wind in one locality, say a few hundred miles in area, may be represented by moving a piece of card paper, with arrows to show directions of the wind, across a part of the earth's

surface, as shown on a large map,—the North Atlantic, for example, between England and Newfoundland. The course of the arrows shows how the wind is circulating in that space ; so that, while the wind is at one point westerly, at another it may be easterly,—here southerly, and there northerly: supposing such a piece of card-board to represent a body of air in circular motion, and at the same time moving *bodily* onwards, as these great meteors (for so they may be called) do move,—that is to say, while circulating around their centres, they are also moving onwards across the earth or ocean's surface.

If such a circular paper be moved towards the north-east from near the Gulf Stream, or from the neighbourhood of the West Indies, across the Atlantic (as we know, from ships' logs and collected observations, such rotatory storms do move), the wind will be represented circulating round, while the meteor, or cyclone, travels on bodily towards the north-east. When first touching Ireland the wind would be south-east, but, as it moves on, the wind there becomes south, and afterwards south-west (the air in such a meteor is supposed to be going round, so that there are different winds in different parts, which may be some hundred miles separated). At London such a cyclone might begin with an east wind—which, as it passed on, would become south-east, south, then south-west, west, and then north-west, and north—owing to the polar current driving the meteoric eddy southward again.

The turn or apparent sequence of the winds is, in these cases, what sailors call right-handed, or with the hands of a watch ; but the meteor itself, or the body of air in motion, moves round contrary to the hands of a watch, while the appearance to the eye seems to be the reverse. Take London again for example. Supposing the beginning of the movement is at London, with an easterly or south-east wind, and that it shifts thence to the south, and south-west, and west, and then by north to north-east,—the effect to our eye is that of the wind shifting "right-handed," as we say it does, or "with the sun," but the wind in the cyclone itself has been going round actually in the opposite direction, or against the sun and contrary to the hands of a watch,—which is, perhaps, the best reference for illustration.

In the southern hemisphere there has been some confusion, owing to our seamen always calling this direction right-handed, or with the sun, and the opposite direction left-handed, whether in the southern or northern hemisphere, although when beyond the tropic in the southern hemisphere, and looking towards the sun, he appears to move "left-handed," as sailors call it. In dealing with circular winds of any kind, it is better to refer to the hands of a watch, rather than to the sailors' expressions, "right or left handed," "with the sun," or "against the sun."

There is a very simple rule in connection with these rotatory winds, which is, in the northern hemisphere, when facing the wind, the centre of its circulation is square to your right, and when in the southern, square to your left hand. All the terms, tornado (twisted), typhoon, cyclone, hurricane, and whirlwind, are but different words expressing the same rotatory movement or circulation, of vastly increased strength at times, but not always excessive in force and duration.

We do not usually feel the total circular effect; we only feel part of

it; the wind shifting only from some point to some others, because the whole meteor does not often go over any one place; a part of it goes across in general, and, therefore, places on one side of its centre are affected differently from those on the other side, where the wind will appear to shift differently. It is generally found that cyclones, instead of passing horizontally, or parallel to the earth's surface, are inclined at an angle (more or less acute) with the horizontal plane, and we therefore feel only parts of them; there may be several such circulations passing or following in the same direction, and revolving similarly, like eddies, with their lower surfaces on one side of the circulating meteor only, touching the earth's surface, the other parts circling in the atmosphere above our heads, so that we only feel a part of the change, and not the whole of it.

When the centre passes over any given spot there is a sudden change from one direction completely to the other, with probably a lull between. If only an extreme or limb passes, there is a gradual change through nearly half the compass—and very seldom is there an instance of greater sensible change than this, through about half the compass, excepting when successive storms follow one another and cause complications.

Professor Espy of the United States has written much of importance on this subject, and has put forward what has been by some supposed to be a different theory; but in fact his theory is a corroboration of Dové's, and supports such general views as are here offered. Professor Espy says that in a circular storm the wind blows from all directions towards the centre, and it can be demonstrated mathematically that the consequence of the wind blowing from over large areas, some hundreds of miles in extent, towards a centre, will be a whirl near the centre, and a comparative lull in the centre, which is what actually takes place. You find the strongest point of the whirlwind near the centre, but not in it; and the further you get from it, the more the wind diverges from the circular course. You may see a similar convergence in a trough of water with a hole in the bottom. If you open that hole the water begins to pour out, and the water near the opening which causes the movement moves fastest—the outer part moves more gradually. In air there is a somewhat similar effect, as there must be an elevation of the central part consequent on rarefaction or evaporation, which draws air from all other quarters: or there must be a *compression* consequent on two bodies of air passing each other and twisting the air forcibly between: as you see in a river, when one body of water passes another, a succession of eddies caused by such a lateral pressure of currents passing each other. So it is in the atmosphere, only that there these eddies are much more complicated, various, and extensive, on account of the extreme *elasticity* of the air, which not only yields to pressure, but has always a tendency to expand again greatly afterwards—a resilient elasticity not found in water, which is almost incompressible and inexpansive.

With reference to this subject, I would refer to a printed passage written by myself as far back as 1838. "Are not storms exceptions to the general winds or atmospheric currents, not the causes of them? Some persons have laid too much stress upon such exceptions, and have rather overlooked the general principal features—those of the conditions which

prevail almost constantly. Common winds occur throughout the year, except during short intervals; but hurricanes, or even ordinary storms, are comparatively rare. May not opposing or passing currents cause eddies or whirls on an immense scale in the air, not only horizontal, but inclined to the horizon, or vertical. In laying a ship to during a storm there are other points to be considered besides the veering of the wind, such as the direction of the sea, with or against a current. I never myself witnessed a storm that blew from more than fifteen points of the compass, either successively or by sudden changes. In most, if not all of the storms to which I can bear testimony, currents of air arriving from different directions appeared to succeed each other or combine together. One usually brought the 'dirt,' to use a sailor's phrase, and another cleared it away, driving much of it back again, often with redoubled fury. One of these currents was warm and moist, another cold and dry, comparatively speaking. While one lasted the barometer fell or was stationary; with another it rose. At all places I have visited, or from which I have obtained notices on the subject, the barometer stands high with easterly, and comparatively low with westerly, winds on an average. Northerly winds in the northern hemisphere affect the barometer like southerly winds in the southern hemisphere."

With reference to foretelling weather, I will quote two or three very short passages, also from my own writing. "It should be remembered that the state of the air foretells, rather than shows, present weather (an invaluable fact too often overlooked)." I refer to foretelling weather now, because it is immediately connected with the general law of rotation, or Dové's law of gyration. "The longer the time between the signs and the change foretold by them, the longer such altered weather will last; and, on the contrary, the less the time between a warning and a change, the shorter will be the continuation of such foretold weather. If the barometer has been about its ordinary height, say near thirty inches at the sea-level, and is steady or rising while the thermometer falls and dampness becomes less, north-westerly, northerly, or north-easterly wind, or less wind, may be expected. On the contrary, if a fall takes place with a rising thermometer and increased dampness, wind and rain (or snow) may be expected from the south-eastward, southward, or south-westward. Exceptions to these rules occur when a north-easterly wind with wet (rain or snow) is impending, before which the barometer often rises (on account of the *direction* of the coming wind alone) and deceives persons who from that sign only expect fair weather." "Three things appear to affect the mercury in the barometer:—1. The direction of the wind; the north-east wind tending to raise it the most, the south-west to lower it the most; and wind from points of the compass between them proportionally as they are nearer one or the other extreme points."

What it is that causes these peculiarities immediately connected with the direction of the wind, whether it is entirely owing to the air, the southerly or equatorial wind, becoming lighter from its warmth, or from some electrical condition which is not traced out as yet, is not clearly proved. If connected with electricity, as is probable, we cannot yet deal accurately with it. Here only those facts are admissible which are distinctly verified.

it; the wind shifting only from some point to some others, because the whole meteor does not often go over any one place; a part of it goes across in general, and, therefore, places on one side of its centre are affected differently from those on the other side, where the wind will appear to shift differently. It is generally found that cyclones, instead of passing horizontally, or parallel to the earth's surface, are inclined at an angle (more or less acute) with the horizontal plane, and we therefore feel only parts of them; there may be several such circulations passing or following in the same direction, and revolving similarly, like eddies, with their lower surfaces on one side of the circulating meteor only, touching the earth's surface, the other parts circling in the atmosphere above our heads, so that we only feel a part of the change, and not the whole of it.

When the centre passes over any given spot there is a sudden change from one direction completely to the other, with probably a lull between. If only an extreme or limb passes, there is a gradual change through nearly half the compass—and very seldom is there an instance of greater sensible change than this, through about half the compass, excepting when successive storms follow one another and cause complications.

Professor Espy of the United States has written much of importance on this subject, and has put forward what has been by some supposed to be a different theory; but in fact his theory is a corroboration of Dové's, and supports such general views as are here offered. Professor Espy says that in a circular storm the wind blows from all directions towards the centre, and it can be demonstrated mathematically that the consequence of the wind blowing from over large areas, some hundreds of miles in extent, towards a centre, will be a whirl near the centre, and a comparative lull in the centre, which is what actually takes place. You find the strongest point of the whirlwind near the centre, but not in it; and the further you get from it, the more the wind diverges from the circular course. You may see a similar convergence in a trough of water with a hole in the bottom. If you open that hole the water begins to pour out, and the water near the opening which causes the movement moves fastest—the outer part moves more gradually. In air there is a somewhat similar effect, as there must be an elevation of the central part consequent on rarefaction or evaporation, which draws air from all other quarters: or there must be a *compression* consequent on two bodies of air passing each other and twisting the air forcibly between: as you see in a river, when one body of water passes another, a succession of eddies caused by such a lateral pressure of currents passing each other. So it is in the atmosphere, only that there these eddies are much more complicated, various, and extensive, on account of the extreme *elasticity* of the air, which not only yields to pressure, but has always a tendency to expand again greatly afterwards—a resilient elasticity not found in water, which is almost incompressible and inexpansive.

With reference to this subject, I would refer to a printed passage written by myself as far back as 1838. "Are not storms exceptions to the general winds or atmospheric currents, not the causes of them? Some persons have laid too much stress upon such exceptions, and have rather overlooked the general principal features—those of the conditions which

prevail almost constantly. Common winds occur throughout the year, except during short intervals; but hurricanes, or even ordinary storms, are comparatively rare. May not opposing or passing currents cause eddies or whirls on an immense scale in the air, not only horizontal, but inclined to the horizon, or vertical. In laying a ship to during a storm there are other points to be considered besides the veering of the wind, such as the direction of the sea, with or against a current. I never myself witnessed a storm that blew from more than fifteen points of the compass, either successively or by sudden changes. In most, if not all of the storms to which I can bear testimony, currents of air arriving from different directions appeared to succeed each other or combine together. One usually brought the 'dirt,' to use a sailor's phrase, and another cleared it away, driving much of it back again, often with redoubled fury. One of these currents was warm and moist, another cold and dry, comparatively speaking. While one lasted the barometer fell or was stationary; with another it rose. At all places I have visited, or from which I have obtained notices on the subject, the barometer stands high with easterly, and comparatively low with westerly, winds on an average. Northerly winds in the northern hemisphere affect the barometer like southerly winds in the southern hemisphere."

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"North-east and south-west may be called the wind's *extreme bearings*." If the wind remain for two or three weeks in either of these quarters, the mercury will remain at its highest or lowest point, the atmosphere appearing steady, with a north-east wind. "The range of difference of height of the mercury due to change of direction *only* from one of these bearings to the other (supposing strength, or force, and moisture to remain the same) amounts in these latitudes to about half an inch, shown by the barometer as read off. 2. The amount, taken by itself, of vapour, moisture, wet, rain, or snow in the wind or current of air (direction and strength remaining the same) seems to cause a change amounting, in an extreme case, to about half an inch; and (3.) the strength or force alone of wind from any quarter (moisture and direction being unchanged) is preceded or foretold by a fall or rise according as the strength will be greater or less, ranging in extreme cases to more than two inches." The barometer is affected to the extent of two inches by the *strength* of the wind, it is affected about half an inch by the quantity of moisture in the air, and perhaps another half-inch by the *direction* only of the wind. As these usually act more or less against each other, and in smaller proportions, the barometer is seldom so greatly affected; and its ordinary changes are not so marked. Such rules have been contracted on the scale of a barometer for the use of fishermen and coasters, in the following manner:

On one side being—		And on the other side—
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"Allowance should invariably be made for the previous state of the column during some days as well as hours, because its indications may be affected by remote causes or by changes close at hand. Some of these changes may occur at a greater or less distance, influencing neighbouring regions, but not visible to each observer whose barometer feels their effect. There may be heavy rains or violent winds beyond the horizon and the view of an observer, by which his instrument may be affected considerably, though no particular change of weather occurs in his immediate locality." "Sometimes severe weather from an equatorial direction not lasting long may cause no great fall of the barometer, because followed by a duration of wind from polar regions, and at times it may fall with polar winds and fine weather, apparently against these rules, because a continuance of equatorial wind is about to follow. By such changes as these one may be misled, and calamity be the consequence if not thus forewarned."

Reference may again be made here to a useful rule. Supposing that a storm is rising, and that a seaman wishes to know where the greatest strength of wind is. If he *faces* the wind, in northern latitude, the centre of the circulation, or cyclone, will be square to his right; and in the southern hemisphere, if he *faces* the wind, the centre will be square to his left; therefore he knows in which direction to go to avoid that part where the greatest strength is, and must shape his course according to circumstances. He can hardly have a simpler rule. His position with reference to distance from the centre, whether it is near the ship or far off, can be ascertained by watching the falling or rising of the barometer, and the way in which the wind shifts. It only requires a sketch upon paper—a rough figure, with an hour or two's observation of the veering of the wind, to know exactly in which direction to steer, without studying any elaborate rules, which sometimes perplex more than they assist the seaman in the hour of need.

Before leaving this part of the subject, I would again advert to the excellence of the Aneroid as a *weather-glass*, if well made. Compensation for heat or cold has lately been introduced by efficient mechanism. In its improved condition, when the cost may be about 5*l.*, it is fit for measuring heights as far as 5,000 feet with approximate accuracy; but even at the price of 3*l.*, as a *weather*-glass only, it is exceedingly valuable, because it can be carried anywhere; and, if now and then compared with a good barometer, it may be relied on thoroughly. There is a place at the back with a screw-head, which may require to be touched occasionally, to reset the instrument, if out of adjustment. I have had one in constant use for ten years, and it appears to be as good now as at first. For a ship, considering the concussion by the fire of guns, for use in boats, to put in a drawer or on a table, I believe there is nothing better for a common "weather-glass."

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rises or falls according to the direction of the wind. Supposing a diagram to represent 36 hours, and divided into spaces of three hours each along the upper horizontal line; while below, points of the compass are shown, from north around by east to north again, and continued to south; and at the side a scale of inches and decimals, from 28 to 31. We may next suppose that the wind has gone round the compass once, or say once and a-half, as happens occasionally; and that it has been an extreme case of depression, as in a storm. Then, if from 30·3, with the wind at north, a shifting occurs, first towards the north-east, and then onward in the same direction around the compass—as the wind so shifts to the north-east, and is about to shift towards the east and south, the barometer foretells it, or falls beforehand. When the wind is north-east the mercury is lower, probably, than when it was at north. As it gets to the east the mercury falls, and gets lower still at south-east, and falls still more to south and south-west, where it is probably the lowest, because it feels the effects of the south-westerly or equatorial current most then, and may be down, let us suppose, to 28·2 inches. As the wind shifts round to south-west, west, north-west, the column in the tube rises, till, perhaps, the wind is north, or even north-east, when it may be as high as 30·8. It has been known in this country as high as 30·9. As the wind goes round again to the east, and south-east, and south, the barometer falls as before, and a line or curve traced upon paper, representing these falls and rises, or oscillations of the barometer, during a certain time, say these 36 hours, has an appearance like the outline of a wave of water; but as these apparent waves, or undulations, take place *exactly* as the wind shifts, and proportionally to its strength—and as, if the wind remains in one quarter for some days, or say two or three weeks together, the curve becomes almost a direct line, remaining at about the same elevation, it seems that there is an intimate and immediate connection between such a curve, or wave line, and the oscillation of the mercury, though not necessarily between the curve and any undulatory movement of the atmosphere above our heads. If a body of the atmosphere above us swelled upwards, like a wave, and fell again, as some suppose, as it were in "crests" and "troughs," how should we reconcile it with the fact of there being various currents passing over each other in the atmosphere in various directions? Aeronauts who have been up in balloons know that from one stratum of air they passed into another, and another, and perhaps a fourth also, moving in different directions. There cannot be *vacancies* between the undulations of various strata of air. These different bodies of atmosphere could not be undulating like waves while having spaces between them, and interferences of cross movements. Waves of ocean have only elastic air above them, which does not impede their rise and fall materially; and they are only superficial.

The effect of such a raising of any part of the mass of air would be that the lighter or equatorial portions, or winds, would rise the highest, and would expand; but, according to the "Wave Theory" (here controverted), the reverse is the fact; you have the lowest part of the apparent trough of the wave, with the lowest barometer, that is, with the air, which is the *lightest* and most *expanded*, and ought (therefore) to rise up the *highest*; and you have, coincident with the heavy dry air, the highest

part, or what is called the "crest," of the wave. Considering then these facts, and the exact correspondence of the movements of the mercury with the wind's direction, besides noticing the extreme variability traceable in such an atmospheric wave, (which can hardly be conceived to be motionless for weeks, as in the case of a steady north-easterly wind, and then going into extraordinary irregularity during a day or two,) we are led to the belief and assertion that what are commonly called "atmospheric waves" are rather delusive; that there are waves in any line indicating oscillations of the barometer, but not traceable in the atmosphere itself, as usually understood by "trough" and "crest" outlines.

Before referring very briefly to the effect of winds upon our own climate generally, I would allude to a few considerations connected with the ocean. It may not perhaps be generally known that over the ocean, in most parts of the world, the average temperature of its superficial water is nearly that of the air near its surface. In the tropics, the temperature of the sea water ranges from 70° to 80° or more, and the air is much the same. In some limited parts of the world the surface water is as warm as 86°, for instance, near the Galapagos Islands; and in some very confined localities, even *more than* 90°, as, for example, in parts of the Red Sea and Indian Archipelago. But, although so warm on the surface, it is very much colder at a few hundred fathoms below, the cold increasing to perhaps 35°. It was long considered that 39° must be the greatest cold that could be found in the lower ocean, being nearly that at which water is condensed; but reliable observations, during the last few years, have shown temperatures apparently as low as 35°. The effect of this great variation of temperature, and therefore in quality of water, or the varying state of the water itself, the action of the winds upon the surface, also of evaporation, of rain, and lunar action, combine to cause constant movement analogous to, if not a circulation of the ocean, like that of the atmosphere, though on a much more limited scale, and perhaps not sensibly affecting very great depths. There is, for instance, the well-known current called the Gulf Stream, which runs from the Floridas across the Atlantic towards Europe, with a temperature ranging from 80° to 60°, and underneath which there is a current which several observers, including Captain Cochrane, have found to be as low in temperature as 36°, or less. Off the Cape of Good Hope there is a similar remarkable mixture of extremes of temperature within a very short distance of each other. The Lagulhas stream, running from near Madagascar, by the coast of Africa and the Cape of Good Hope, has a temperature of 70°; but near the Cape meets with cold water from the Antarctic regions, at a temperature ranging from 40° to 50°; and these currents occasionally intermingle, sometimes near the surface, sometimes below it, so that one may dip a thermometer in the water at one hour, and find 45° or 46°, and an hour or two afterwards find from 65° to 70°. Similar places occur in the Pacific Ocean, and one very marked, near the Galapagos Islands, on the north-west and south-east sides of the group.

The effect of such warmth of sea-water, particularly that of the Gulf Stream, upon our own climate, and the waters that are near the shores of other countries upon land adjacent to them, need hardly be referred to even in passing, except to remark that wind blowing over a body of

warm sea-water is warmed and otherwise affected perhaps chemically.* Those countries which are exposed to the sea-winds of the lower and middle latitudes all round the world, in the northern as well as in the southern hemisphere, bringing moisture and warmth with them, are milder in climate and more favourable to vegetation than those countries which are exposed to dry land winds, whether hot or cold. Tropical, or other east winds, from over an expanse of ocean, carry vapours and rain. But they differ in some respects from the westerly. Polar currents in general carry but little moisture, excepting where they have passed over, immediately before reaching the land, a considerable expanse of ocean, whence they have taken up evaporated moisture, and therefore acquired a character more like that of ordinary sea winds, though not so moist and beneficial in nature. Generally speaking, sea winds are more or less charged with vapour, but land winds are usually dry and very different in their qualities, according to the country traversed.

It has been much discussed in Scotland within the last two or three years whether the Gulf Stream has really so much effect upon our climate as has been usually thought, and it has been chiefly questioned because experiments have been made with thermometers close in-shore, within twenty or thirty fathoms, where the water has been affected more or less by rivers, or the land near it, and has not been found nearly so warm as the winds or water of the Atlantic—but this seems to be rather a fallacious ground of argument. There is no doubt that along the coast of Norway, as well as the coasts of Scotland and the Hebrides, the warming effect is such that all ice is kept out of the harbours there. The climate is mild all the year round, even at the North Cape; while on the western, or the opposite side of the Atlantic, ice comes down in-shore to a very much lower latitude, even below Newfoundland.

The Consul-General for Norway (J. R. Crowe, Esq. now in London) says, that within the last few hundred years ice has increased along the east coast of Greenland very much, according to authentic records which he has consulted. There were colonies, several centuries ago, on the east shore of Greenland, then an open coast, which were destroyed by being blocked up by ice, and have never been heard of since.

The space between Iceland and Greenland is now blocked up entirely, although some centuries ago it was quite open; while between Iceland and Nova Zembla there is still a very large space of open water, and for 200 miles round the Naze, or North Cape of Norway, *no ice is ever seen.* The Gulf Stream is found to communicate its effects across the Atlantic by more or less narrow streams, or threads, of warm water, even to the eastward of North Cape, where none of the harbours are frozen up throughout the year, and where fishermen work in lighter clothes than they use further to the southward.

In some countries, where the wind blows almost constantly in one direction, vegetation is abundant on the side against which the wind blows from the ocean, an inexhaustible source of moisture, while on the other side there is scarcely any vegetation at all; as in Peru, Patagonia, parts of Arabia and Africa, various islands, parts of Asia and of Australia, where all the moisture from the sea winds has been condensed and

* *e.g.* Ozone.

extracted; and in passing across extensive land, the other sea-side, as in Peru, receives only dried air from the land, and the country is more or less barren. So in many other places, wind carrying moisture affects one side of a hill or mountain, and does not affect the other equally. Our own climate being exposed to south-westerly, westerly, and southerly winds for about three-fourths of the year, is remarkably favoured in this respect, as these winds are not only moist, but warmed in passing over the warm waters of the ocean, both tropical, and of the more expanded part of the Gulf Stream.

There can be no fear of any material change in our climate under such peculiar circumstances, but it may be very questionable how far the northern regions,—those in the latitude of Iceland and from Newfoundland across to Norway,—how far these countries may be affected by the increase or diminution of ice in the Arctic regions; and this is a question which may also have its weight with reference to our own seasons.

The temperatures of the depths of the ocean have been ascertained by thermometers peculiarly constructed, self-registering, and showing maximum as well as *minimum* temperatures, or minimum only, which is probably sufficient, and admits of the instrument being *narrower*, a considerable advantage in *sounding*. Such instruments must be strong enough to resist the pressure of the ocean at two or three miles depth, where there may be a force exerted to compress them, exceeding two hundred, perhaps three hundred, atmospheres (of 15 lbs. to the square inch).

The specific gravity of the ocean has been tried lately, in nearly all parts of the world, by small glass hydrometers; and the general result is that the specific gravity of the salt water is very much the same in all places, except where affected by recent heavy rains, or by water from the mouths of large rivers ; the differences in the specific gravity being found to be less usually than the common errors of observation with the hydrometer, which may occur if it is put into water without being carefully wiped. From the mere carelessness of not thus cleaning it, a difference of two or three divisions of the scale may be caused. The instrument is however *very accurate if correctly used.*

The general result seems to be established that the ocean is almost everywhere at the surface within one or two divisions of 1,027 (calling distilled water 1,000 grains), the sea-water averaging 1,027 grains in weight. The difference between various parts of the ocean, taking the whole world, being not more than 2 or 3 of these divisions from 1,027, or from 26, in short, to about 28, which is, as I said, rather less than the difference between using the instrument carelessly and accurately. In the Red Sea a specific gravity considerably higher than 1,028 is said to have been found; and some of the eastern seas show similar exceptional instances (*said* to extend to 1,080 in the Red Sea.)

Interest has been caused lately by what is called Ozone, which has been thought to affect health considerably. Whatever may be the real chemical or philosophical explanation, the known facts at present appear to be that ozone is chiefly found on or near the sea, and that winds which blow towards the land from the nearest sea bring the most ozone. Lieutenant Chimmo has lately observed that in the Hebrides, and on the north-west coast of Scotland, there is more ozone than he found in other

places, including the great ocean, and, on comparing notes from different parts of our own coasts, it is remarkable that the wind which accompanies the greatest indications of ozone is that which blows from the nearest and largest sea. When Mr. Jansen, of Holland, and Dr. Mitchell, of Edinburgh, made observations in India, in the Atlantic, and in Algeria —Mr. Jansen's being between Batavia and England—they found, by independent methods, that over the sea, clear of the land, there was most ozone, and that over land or hills near the sea—hills against which the sea-winds blew—there was more than in the valleys or in other places which were separated from the sea, and that inland, about towns, and in inland places generally, there was exceedingly little.

This seems to point to a connection between ozone and chlorine gas, which is in and over sea-water, and which *must* be brought by any wind that blows from the sea. I will not here make any further reference to its peculiarities, except one—its possible affection of the gastric juice—as it is a rather too purely chemical question. I will only repeat, that at present the results of various different observations of ozone show that the greater prevalence of it is with wind that blows from the nearest sea ; and that it prevails more over the ocean and near it than over land, especially land remote from sea.

It is intended in the course of the next twelve months to endeavour to obtain simultaneous observations of wind, weather, and other meteorological information, over the whole Atlantic, and round the coasts of this ocean, by enlisting the aid of observers in every quarter, for one or two observations only, in each day ; with a view of getting at the exact state of each portion of the atmosphere, over our nearest ocean, during one particular time, on certain days, and then mutually comparing those successive and synoptic *views*, as it were, of the atmosphere, in order to discover the usual or normal sequence or succession of winds and weather, as more particularly affecting seamen and agriculturists. A memorandum has been circulated, and instruments specially suited have been lately forwarded to Halifax, Bermuda, and other places. The following extracts are from that memorandum :—

" The Royal Society and British Association for the Advancement of Science, having made official application to Government in favour of the establishment of anemometers at certain selected stations, the Meteorological Department of the Board of Trade and Admiralty has prepared two such instruments, and arranged for their conveyance to Halifax and Bermuda. It is proposed to request the principal authorities at each place to give aid in placing the anemometer and arranging for careful attention to it once a-day during the limited period of intended investigation of atmospheric laws throughout the Atlantic ocean.

" This period will commence at Midsummer next, and continue uninterruptedly until the following midsummer. During this interval of twelve months a collection of meteorological information will be sought from every part of the Atlantic Ocean—from ships, and from observers on its coasts and islands.

" It seems only necessary to state the object in view, and how the undertaking originated and is supported, to ensure hearty co-operation."

The scientific questions at issue that will derive so much advantage

from the great collection of observations that is now being made in America, France, Holland, and this country, should not be allowed to extend indefinitely, lest the data should grow overwhelming. Up to the present time the practical results, as far as navigation, and what one may call "weather wisdom," are concerned, are satisfactory. On board ships, attention to signs of the weather, to winds and currents, and magnetism,—and consequent avoidance of accidents, besides saving life,—have been remarkable.

On our own coasts there is now, in almost every fishing village, some kind of barometer, and attention is paid to its signs of weather. Fishermen do not often now go out at hazard, but watch the instrument and the sky, and judge for themselves. If practical results of meteorological investigation can be turned to account even thus in the present day, besides gathering materials for scientific men hereafter, those who co-operate is the work must have reason for conscientious satisfaction, which indeed in their highest reward.

CHAIRMAN.—The elaborate and instructive lecture which Admiral FitzRoy has given us has been listened to with the greatest interest and attention. Seeing the beneficial results that have followed already from such labours, I have no doubt that at some future day, when further carried out, not only many ships, but very numerous lives, will have been saved, in addition to all the commercial and purely scientific advantages derived. I beg to call upon you now to join me in a vote of thanks to Admiral FitzRoy for his lecture.

The motion was carried unanimously.

Tuesday, March 29.

Colonel the Hon. J. LINDSAY in the Chair.

THE VALLEY OF THE YANG-TSE-KEANG, BEFORE AND SINCE THE INROADS OF THE REBELS, AS FAR AS THE COMMERCIAL MART OF HANKOW: Partly from Personal Observations.

By Sir John F. Davis, Bart. K.C.B. Member of the United Service Institution.

The Keang, or Great River of China, has been laid open by the Treaty of Tien-tsin up to the central mart of Hankow, a distance of more than 500 miles from its mouth below Nanking. Having myself journeyed along 300 miles of that distance, from the extremity of the Grand Canal to the Poyang Lake, I purpose to state the results of my own observations to that extent, and to supply the rest from the experience of others. The fruits of Lord Elgin's adventurous and most interesting expedition are now before us, and I purpose to introduce these by a condensed summary of what has been known before, and then proceed to institute a comparison between the former and present states of the country (before and since the devastations of the rebels), as the ground of our just anticipations for the future.

The whole tract in question lies, with little exception, between thirty and thirty-two degrees of north latitude, the favoured climate of tea and silk, our principal imports, and including some of the finest portions of China. Commencing by the mouth or delta of the river, we have the long alluvial island of Tsoong-ming, about thirty miles in length, and called from its shape and position *Keang-shĕ*, the "tongue of the river." A small party landed here during our first war and lost an officer, whence that spot at the west end was called Harvey Point. Its principal town, *Tsoong-ming-Hien*, on the south coast, is only a town of the third class. The canals with which the island abounds have high embankments to preserve the country from floods, especially dangerous from the low, flat, and alluvial formation of the land. The dense population has resulted as the effect of Chinese industry exerted on a naturally fertile soil. The portion least cultivated is the north side, abounding in those coarse high reeds which are found on the low shores or islands of the river higher up, and which serve, in combination with mud, to form embankments and even dwellings, as well as occasionally answering the purposes of fuel. A portion of the soil in the northern part is so saturated with sea salt as to form a fund for the supply of the whole island, with a large surplus

for the main land itself.* The southern portion is the most fertile and cultivated division of the island, producing rice, wheat, barley, and millet.

From the western extremity of Tsoong-ming to Chin-keang on the Grand Canal, which is the first point of much interest on the river, the total distance, with windings, is about 125 miles. That so long a tract should be comparatively destitute of large towns,† is explained by the fact, that the government, aware of the accessibility of Nanking and the Grand Canal from the sea, has always discouraged the navigation below Chin-keang, the canal itself supplying an inland transit independent of the sea-coast. This portion of the river was an unknown mystery until Admiral Sir William Parker in 1842 conducted seventy men-of-war or transports to Nanking without the loss of a vessel, where no European keel had ever ploughed before. This, and the late expedition of five war steamers all the way to Hankow, in spite of difficulties generally deemed insurmountable, are exploits of which our navy may justly be proud. I have known many instances in the far East where they have had the good fortune to succour foreign ships in trouble; and I cannot call to mind any occasion on which they have had to claim foreign aid themselves.

It is at Chin-keang that my own acquaintance with the great river begins, and continues to the Poyang Lake, about 150 miles short of our treaty limit at Hankow. Journeying in the boats of the country, the difficulties of the passage to a large squadron of Chinese vessels, against the stream and a contrary wind, occupied no less a time than from the 19th of October to the 14th of November, or little more than ten miles a day, leaving abundance of time for excursions and observation. It conveys some idea of the breadth of the river (when full from two to five miles in breadth) when I state that it frequently afforded a tolerable horizon for ascertaining the latitude.

The neighbourhood of Nanking has become so comparatively familiar to us that we may pass on at once to a higher and less known point, which we reached on the 29th October, namely, Se-leang-Shan, the "western pillar hill," a remarkable high rock, which, with the "eastern pillar hill" on the opposite shore, forms the *Gades* of the Keang, about thirty-five miles above Nanking. From the top of the western rock, a height of 500 feet, we observed the broad channel of the river, as it flows between two lines of mountains to the sea. This is a remarkable spot among the Chinese themselves (in peaceable times); and the well-built town at the foot of the rock seemed to owe its existence to the influx of visitors. On the 30th October, the strength of the stream and the want

* This article is so superabundant as to render its importation from abroad a rather profitless speculation. It was a part of my business in China to decide against its importation, in accordance with the fiscal regulations of the government, with whom it is a very important source of revenue; and I observe that, by the trade regulations appended to Lord Elgin's recent treaty at Tientsin, this decision has been confirmed, by the article of salt being expressly excluded.

† The chief towns which succeed each other on the north bank are Tung-chow, Tsing-keang-Hien, and Tae-yu-Hien; on the south bank are Too-paou-Hien and Yeh-shan-Hien,—all of them towns of the second and third order.

of wind obliged us to stop at Wu-hu, a very considerable town about ten miles above the "pillar rocks," and dependent on Taeping. In proof that the technical classification of Chinese towns does not always indicate their real size and importance, this appeared to be superior to many of their first-class cities; and it is to the great inland commerce carried on by this town that such unusual wealth and prosperity are to be referred. We here first observed bales of cloth with the English mark upon them, about 600 miles from Canton, inland.

Quitting Wu-hu on the 31st October, we started with a north-west wind, and, our course here being sometimes due south, we made more progress than usual, accomplishing a hundred lees, or thirty miles, by the time the boats reached the mouth of a tributary river named *Teih-Keang* on the right bank, in which we anchored, near a small town built at the foot of some low hills. The Emperor's desire to get rid of us by the shortest route was the fortunate occasion of our thus navigating the Keang between the Grand Canal and the Poyang Lake, instead of following the beaten track of low marshes along the remainder of the canal. After travelling through the swamps of Shantung and the north of Keang-nân, we were now in a country that could yield to none in the whole world, and is equalled by very few. It was justly remarked by the late Sir Henry Ellis, one of our party up the Keang, "However absurd the pretensions of the Emperor of China to universal supremacy, it is impossible to travel through his dominions without feeling that he has the finest country within an imperial ring-fence in the world." After the lapse of about a fortnight we were, owing to contrary winds, and the timidity of our boatmen, not advanced one-half of the way to the lake; but this delay only afforded the more time for observation and inland excursions, which met with no opposition from our conductors.

On the 1st November, we advanced only twelve miles, to Tsing-kea-chin, on an island which divides the stream of the Keang, and above which the river spreads to a breadth of nearly five miles, after describing what appeared to us a considerable portion of a circle round two islands. On the 2nd, as early as nine o'clock, we found the whole squadron of boats anchored at the considerable town of *Tung-ling Hien** on the right bank, eighteen miles from Teih-keang. Thinking we were to stop for the day, some of us set out as usual on a ramble through the town into the country beyond, but in the course of an hour the wind became fair and the boats prepared to sail. We had extended our excursion to about two hours, when some Chinese came hallooing and announcing the departure of the fleet, and we did not conclude our chase of the boats on their way, up until four hours after quitting them.

On the morning of the 3rd November we were anchored at a town called *Tatung Chin*, on the right bank, and opposite to those long islands by which the Keang is so often divided. We were detained here by contrary winds for no less than five days, which were spent in exploring those beautiful hills at the foot of which the town lies. Our excursions extended to circuits of fifteen and sixteen miles, when we often came across tea

* The name denotes "copper mountains," and Du Halde speaks of a valuable *green stone* found here, probably malachite, or copper ore

plantations, though here less frequent than in the south-east parts of *Keang-nan*, and in *Chĕ-keang* and *Fokien*.

On the morning of the 7th of November it blew strong from the north-east, and we made one of our best days' journeys, arriving in the afternoon at Woosha-kea, or "Black Sand Fork," *kea* meaning one of those numerous points where the Keang forks out into two branches to compass an island in the middle. As we were about to enter again on the main stream, our conductors thought it prudent to remain until the wind moderated. Nothing was more surprising than the difference between the Chinese sailors of Canton and their "long-shore" brethren of the Keang. The boats were almost as different as the boatmen; for, while the Canton boats are strongly built and capable of buffeting with the waves, these great square boxes, clamped with iron at the joinings, seemed really to justify the apprehensions of their conductors. This difference may partly be ascribed to the habit of occasionally encountering the sea near Canton, and partly to the long experience and example of Europeans at that place.

On our way to the present anchorage we passed the city of Chee-chow on the right bank. Du Halde describes this as having six dependent towns, and, though surrounded by the lofty hills which we observed from the boats, rich in territory and trade. The wind on the 8th being too strong for our clumsy craft and lubberly sailors, we remained at anchor, but early on the morning of the 9th started with a fair breeze, and after traversing about one hundred lees, or thirty miles, anchored on the further or western side of Ganking, an important first-class city. Du Halde describes the position of this large town as very advantageous, and states that a Tartar garrison was kept there for the command of the Keang and the neighbouring lake. We must have passed this on approaching the east side of the city, where 500 men in line made a good appearance. Our examination of the interior and suburbs conveyed a favourable impression of the place, where we found very good porcelain shops, indicating our approach to the neighbourhood of King-te-chin, the chief place of its production.

We left Ganking at an early hour on the morning of the 10th November, and, after the best day's run since entering China, viz., 125 lees, or nearly forty miles, reached a place called Hwa-yuen Chin, or the "flower-garden station," about five miles short of Wangshan Hien, or the left bank. On our way here, we passed Tung-lew Hien, on the right bank, a walled city of the third class, but containing within its extensive enceinte fewer streets than dwellings and gardens. The most populous part of the place was on the outside of the walls, between them and the river. The houses in this part of the country were white-washed, which gave them an European look. Parts of the river, even as high as this, appeared not less than three miles across, and huge porpoises were rolling along near our boats, as they do at sea.

After being detained at Hwa-yuen Chin for a whole day, we sailed on the 12th November, and soon came to a part of the river where it is again divided by a long island into two streams, and, proceeding along the south or right bank, we passed Ma-tung-shan, "Stirrup-iron Hill," a curious bluff point; and towards evening approached a very remarkable

insulated rock, rising precipitously from the stream to the height of 250 feet. This (with another larger one at the entrance of the Poyang Lake) is celebrated in China by the name of Seao-koo-shan, "the Little Solitary, or Orphan, Rock." It appeared inaccessible on all points, except one, and here the Buddhist priests had contrived to erect some of their temples on terraces, rising one above the other. But the most remarkable feature was the countless swarm of pelicans, or fishing cormorants, which darkened the face of the rock by their numbers.

We had now entered the limits of the Keangse province, and the first walled town we passed, by name Peng-tse Hien, was, in point of position, the most remarkable we had seen. It lay on the right bank, nestled in a romantic valley, or rather amphitheatre, formed by the lofty hills around, but open to the river. Among native drawings of remarkable places, I possess one of these, as well as of the "Orphan Rock"—both of them especially noticed in Lord Elgin's expedition.

The weather became thick and boisterous, but we proceeded, and our boat with some difficulty reached Kin-kang-leaou, our destined resting place, being a village of small note at the mouth of a creek on the north or left bank of the river. We passed the 13th also at this anchorage, which the Chinese itinerary stated to be about sixty lees, or some twenty miles, from the mouth of the Poyang Lake. We became naturally anxious to inspect this famous inland sea, which, however, though about seventy miles long, is only the second of the empire in size, and yields greatly to the Tong-ting Lake, also fed by the Keang, but considerably above Hankow.

We set sail early on the 14th November towards the Poyang. On the bold and hilly shore to our left (the right bank), we passed Hu-kow, at the "Lake's Mouth," as the name implies. Here, after little less than a month's protracted journey over a distance, by the Chinese itinerary, of 950 lees, and our own calculation 280 miles, from the canal, we quitted the magnificent Keang to cross the lake on our way towards the south, already 400 miles from its mouth, but yet 2,000 short of its source. The entrance to the lake was about a mile wide, and after passing this we came upon the Takoo-shan, or "Great Solitary Rock," rising out of the waters of the vast lake, and larger than the others, but less picturesque and striking in effect.

For the rest of the route to Hankow, we were indebted (previous to Lord Elgin's Expedition) to Du Halde and M. Huc. The remaining distance from hence is about 157 miles. The first large city is Kew-keang, a few miles past the entrance of the lake, with the lake on its east, and the river on its north side. Du Halde states, from the Jesuits' survey, that the tide is apparent here at new and full moon. He speaks of the porpoises, which we had ourselves observed, and states besides that salmon and sturgeon are caught as high up as this point. After averaging a westward course for about twenty miles to the mouth of a river on the right bank, flowing in from Hing-kwo, the Keang lies north-west and south-east from Hankow, the first city of consequence being Hwang-chow on the left bank. Du Halde observes of this, that its neighbourhood to the great centre of commerce, Hankow, and the lakes and rivers in which the vicinity abounds, naturally render it very commercial and opulent. The country is highly

cultivated, and rendered very picturesque by the hills on the north. Under its jurisdiction are eight towns of the third (Hien), and one of the second order (Chow).

Seventy or eighty miles above this city we reach the important central point where the three great towns of Wuchang, Hanyang, and Hankow, lie at the confluence of the Han-keang with the Yang-tse. This affluent of the great river is in itself no inconsiderable stream, running a course of six or seven hundred miles, including windings. The three great cities form a sort of triangle, separated only by the water from each other. Wuchang is the capital of the double province Hu-kwang (north and south) and the residence of the Governor-General. Du Halde observes, "Voutchang est comme le centre de tout l'empire, et le lieu d'où il est plus aisé de se répandre dans les autres provinces." He adds, that it is "le lieu le plus peuplé, et du plus grand abord de la Chine." To any one who has seen Shanghae, this must seem surprising. It is placed opposite to the confluence of the Hankeang with the Yang-tse. "Doubtless," says Du Halde, "in viewing only this forest of masts, which borders that noble river the Keang, about a league in breadth at such a distance from the sea, there is sufficient ground for admiration; but if on mounting some height one comes to discover that vast tract all covered over with buildings, one scarcely believes one's sight, or at least one believes it to be the finest thing in the world of its kind."

Han-yang, the second city of Hu-kwang, is separated from the above only by the Keang, and lies at the western angle made by the confluence of the Hankeang with the Yang-tse. Hankow, on the opposite angle, is the mere growth of this immense commerce, which, in China, seems often to escape from the municipal trammels of the interior of walled cities, and to fix itself on the outside, in order to breathe more freely.

It is some drawback to the splendid prospect held out to our future trade, to consider that the valley of the Keang, from Chin-keang and Nanking to beyond Hankow, either is now, or has been for years, in the power of the rebels; and that, as their occupation and pursuit have been civil war and rapine instead of trade, the baneful effects must be very perceptible. But every one who has only seen how speedily the Chinese repair the disasters of a fire, may feel sanguine as to the healing results of their indomitable industry:

"Mox reficit rates
Quassas, indocilis pauperiem pati."

The adventurous and most interesting visit of Lord Elgin to Hankow now enables us to judge of the existing state of the Keang and its cities. The Retribution, Furious, and Cruiser war-steamers, and Dove and Lee gun-boats, left Shanghae on the 9th of November. The shifting sands and shoals of the river had completely altered its channels as far as Chin-keang since the survey of 1842, and the squadron did not reach that point under a week, when, as an additional delay, the Furious struck on a sunken rock between the south bank and Silver Island. On the 20th of November they reached the head quarters of the rebels at Nanking. Having been fired on pretty sharply in passing, the wise resolution was

formed to drop down next morning with the stream and administer such a lesson as would prevent the Chinese repeating the aggression on the return of the squadron; and this was done in the completest manner. It must be remarked that the Emperor's fleet, close at hand, was encouraged thereby to make an attack on the rebels' position immediately afterwards, though at a safe distance; a style of warfare which accounts for this civil strife having dragged on in a chronic state for so many years. The condition of the rebels, however, is decidedly retrograde. They have been driven from Chin-keang, which they before occupied on the canal; their floating force has been displaced by the Emperor's war-junks along the whole of the Keang; and the expedition observed that the besieging imperial army formed a complete semicircle about Nanking by land.

The lesson at head-quarters was probably the cause of amicable overtures being made from the rebel city of *Tae-ping* on the right bank; and when our squadron reached *Wu-hu* on the 23rd, after serious detentions by shoals, here again their fame had preceded them, and they were civilly received by the insurgents, whose appearance and condition conveyed anything but a favourable impression of their character and resources.

The present expedition was just one month later in the season than that in which I was a traveller, and the fallen condition of the river obliged the Retribution to remain at *Kew-hien*, literally "old town," some twenty-five miles above Wu-hu, and almost the only place in possession of the Emperor's forces on the south bank, from Nanking to the highest point of rebel occupation towards the lake. Their chief stations are Nanking and Wu-hu on the south, and Ganking on the north.

On the 26th November the expedition reached Ganking, the last post of the rebels to the westward. Being on the north or left bank, and the insurgents having no means of communication across, while the city was actually beleagured by the Imperialists, the proceedings at Nanking and elsewhere were probably unknown, and hence a fire was opened on our expedition, which was soon silenced. The Emperor's force again at this place was encouraged by what took place to attack the rebels after the steamers passed on. These indications have an important bearing on what may be anticipated in the future. They indicate a due appreciation of our power by the Imperial government, and must induce them to have us rather as friends than enemies. The sandbanks again impeded the navigation on approaching the Poyang Lake; thereabouts a few trading junks were for the first time observed, and the expedition was as much struck by the appearance of the "Orphan" or "Solitary Rock" (before described) as we had been so many years previously. After passing the Lake's mouth on the way to Hankow, the city of Kew-keang, on the south bank, was found in a state of complete desolation, though for some time abandoned by the rebels. At *Kechow*, further on, was observed the boldest and finest scenery on the river, which is here contracted within a gorge formed by the mountains on both sides.

It was not until the 6th December that the expedition reached Hankow, little less than a month after quitting Shanghae; but still not much longer than I was myself travelling (under Chinese conduct) only from Chinkeang to the Poyang, about half the distance.

After previous accounts, the actual condition of Hankow was especially

disappointing. Every dwelling and building in the place had been demolished during the previous occupation by the rebels; but still much had been restored. The shops and warehouses in one quarter are stated to have been unusually large and well-furnished, with a surprising supply of English and European goods. The opposite city of Hanyang was still a waste of ruins; but Wuchang, the provincial city on the south shore, appeared in a much better condition, and corresponded more nearly with former accounts, exciting, indeed, considerable admiration in the expedition.

The population had, of course, suffered by the remorseless civil war almost to extinction, and could afford no ground whatever for an estimate of its former numbers. The reception given by the Governor-General of two provinces to Lord Elgin was a very handsome one, promoted to some extent, no doubt, by what had been done to the rebels on the way up; and the people showed the greatest curiosity and desire to trade.

On the 11th December, the expedition quitted Hankow on its return, and, after proceeding about thirty miles, found that the river was rapidly falling. After a week's incessant labour in working the steamers over the shoals, only 130 miles had been accomplished, and, on reaching the bar at the Poyang Lake, not more than eleven feet water remained, the Furious drawing fifteen feet. In fact, seven feet of water had fallen since they went up. Here the Furious and Cruiser were left, while Lord Elgin and suite proceeded in the Dove and Lee to join the Retribution lower down. On the 29th December the three steamers reached Nanking.

The rebels displayed, as might have been expected, a very peaceful disposition after their previous chastisement; and a visit being paid to the rebel chief, the interior of Nanking exhibited the same scene of ruin and desolation as the other places occupied by the rebels, whose sole business seems to be destruction without any reproduction. It was evident they were hard pressed by the Emperor's force, and one of the chiefs made secret proposals to the English party to be allowed to desert his colours. Arrangements were effected for safe communication with the two ships up the river, and the mission reached Shanghae on the 1st January, after more than seven weeks' absence.

It is impossible to anticipate any other than the best results from this well-timed expedition by Lord Elgin. It seems to have tested with success the good intentions of the Peking government, if we may judge from the conduct of their representative, the viceroy of Hu-kwang. But had it produced no other result than to establish a proper understanding with the rebels, and show them the folly of aggressive measures towards our people, this alone was worth having. The court of Peking probably hopes from us something better for itself than perfect neutrality towards the rebels, and may have been confirmed in this hope by what the squadron, in mere self-defence, was compelled to do against them up the river. Should this tend to secure good faith and practical sincerity in the observance of the new Treaty, we may accept the results with satisfaction, without troubling ourselves as to the disinterestedness and purity of the motives. If the authorities are encouraged to strenuous exertion, and put a final end to the rebellion which is desolating the country and paralyzing trade, this will be a great common benefit.

Friday, April 1st.

General Sir JOHN F. BURGOYNE, Bart. G.C.B. in the Chair.

THE RIFLE AND THE SPADE, OR THE FUTURE OF FIELD OPERATIONS.

By Captain TYLER, R.E.

BESIDES other divisions, the art of war may be considered, in a military point of view, under three heads—

1st. The attack of fortresses, or siege operations.

2ndly. The conduct of an army in the field, or field operations.

3rdly. The defence of fortresses, and the modes of construction to be adopted in defensive works.

And there is no question more interesting to military men, or more important to the world in general, at the present day, than that of the effect which the modern rifle may be expected to produce, on these different operations, respectively.

I had the honour of treating "on the influence of the rifle upon siege operations" in this place last year; I propose to-day to consider its probable influence on field operations, to the best of my ability, and as far as time will allow; and I hope to be permitted, on a future occasion, to discuss this question with reference to the third of the above headings.

I make no apology for thus coming forward, although I do so with great deference to many amongst my audience who are much better qualified to speak upon the subject. I think it is of great importance, and that it is the duty of military men, to discuss this question. I believe that, by careful study and reflection, we may, looking from our own point of view, each add our mite to its better understanding; and I know how indulgent an audience of this sort always is, to one who searches earnestly after truth in any field, whether they agree with him in opinion, or whether they do not.

A great deal has been said and written, during the last ten years, at home and abroad, on our subject of to-day; and the discussions that have arisen, though dealing at the same time with other questions involved, have mainly turned upon the relative capabilities of riflemen and field artillery. In our own country, we have had the advantage of seeing this point somewhat warmly contested, and we are therefore the better able to form our conclusions in regard to it.

The disciples of the rifle commence by giving us most formidable results. They tell us that well-trained men, judging their own distances, can shoot with the Enfield rifle accurately at 600 yards, and effectively up to 1,000 yards, or even more upon occasion. They have the Lancaster rifle, which shoots better than the Enfield rifle; the Whitworth rifle, which shoots better still; and Colonel Jacob, himself an artillery officer, informs

us that he has gone so far as to blow up an ammunition waggon with one of his explosive bullets, when shooting from the shoulder, at the astonishing distance of 1,800 yards. Trying their weapons at different-sized targets, made to represent columns of men, or field artillery, or bodies of cavalry, they astonish themselves and others by the results they can produce; and they come to the conclusion that neither cavalry, nor the field artillery, that played such an important part in former wars, will be able to stand against them.

Certain officers of artillery, who naturally do not like to be driven out of the field in this summary manner, give us their side of the question. They tell us that these new rifles may become troublesome to them, but that they will not be so formidable on active service as they appear to be in home practice; that there is not sufficient intelligence in the army to admit of good shooting becoming very general; that, where accurate rifle shooting ends, there the action of spherical case begins; that the artillerymen have a great advantage over the riflemen in watching the action of their shot, and in thus getting their ranges more accurately; and that they fire with greater steadiness. A distinguished officer has stated in this theatre, that "It would be unfortunate if anything should tend to disturb the proper relationship that ought to subsist between the three arms; that no good or decisive results can be anticipated on land or at sea by playing at 'long bowls;' that that infantry or that vessel of war which shrinks not from opening fire against an adversary at ranges of about 400 yards and under, and delivers its fire with the greatest efficiency, coolness, and determination, will come off best; and that, if rapid and decisive results are to be aimed at in future wars, they will only be attained by using the superior arm which our soldiers now possess, at distances not materially varying from those at which they formerly attempted, with inefficient means, to do their duty."

One who has written in the *United Service Journal*, also, under the title of "A Field Officer of Artillery," gives us an interesting little bit of Crimean experience, the truth of which has been amply confirmed from other quarters. He says, "The miserable combat before Sebastopol in this respect, when no man dare stir even to assist a wounded comrade without catching the eye and provoking the skill of some hidden sharpshooter, is not a species of fighting which we would like to see carried out on a larger scale with armies in the field;" and he adds, "that the bold bowmen of Crecy and Agincourt would scarcely appreciate the compliment of being classed by Colonel Jacob with men whose courage is to be displayed by their skill in destroying an enemy with a minimum amount of danger to themselves."

The Commandant at Hythe replies to some of these arguments in his official Report for the year ending March, 1857. He gives us a measure of the capabilities and intelligence of those with whom he had to deal during the previous year, by telling us that 61·11 per cent. of the officers instructed, and 55·29 per cent. of the men, attained to the first of three classes in shooting; while 84 per cent. of the officers, and 79 per cent. of the men, ranked in the first class in judging distances. And he adds, "I am quite satisfied from what I have seen, that the private soldiers of the Infantry generally are quite intelligent enough to acquire a sufficient

knowledge, theoretically and practically, in the use of their rifle, so as to render them more than a match for any field artillery at present in existence."

Such is the nature of the discussion that has been carried on, and I am sorry my time will not allow of my referring to it more at length. Since it has taken place, the powers of Sir William Armstrong's gun have been brought to light, and they have given us a foretaste of what we are now to expect from rifled artillery. The principles advocated by Mr. Whitworth in regard to the rifling of guns, promise at least as well as those which have been so successfully adopted by Sir William Armstrong; but the latter has succeeded in introducing a system of loading at the breech; and his fuze and projectiles have hitherto distanced all competitors. We may hope that these gentlemen, and others perhaps also, will make rapid progress in bringing rifled artillery to greater perfection, now that so important a start has been obtained. Rifled guns will, however, be even more valuable in consequence of their increased precision at ranges of from 1,000 to 3,000 yards, and of their lower and more equable trajectory, than on account of the still greater ranges that may be obtained from them.

This increased range and accuracy will be of immense importance on occasions where such qualities are required; but will not so much assist artillery, even when such weapons as the Armstrong shells are employed, in its action against wholly or partially concealed skirmishers, extended along its front and around its flanks. In the field, particularly, where it is very desirable not to waste artillery ammunition on fruitless objects, it would be unwise to make use of these projectiles against men so posted; and, indeed, in hardly any case would their great powers be profitably employed in a contest with *extended* skirmishers at the present distant musketry ranges. Let us proceed to look a little more closely into the subject.

We must admit, in the first place, that small-arm practice in the field will be less accurate than similar practice at a painted target. The weapon, indeed, will be the same, and its range will be as formidable, but the dust, turmoil, smoke, and excitement of the battle-field will detract from the accurate aim of the men; and irregularities of the ground will much interfere with extreme ranges. We cannot suppose, however, that the British soldier,—who has hitherto been so remarkable for his steadiness under fire,—whose cool behaviour in line, against dense advancing columns, produced in the Peninsula, as Sir William Napier says, the most destructive fire ever known,—who, when acting with the inferior weapons of former days, against the previously invincible veterans of Napoleon, reserved his fire until his enemy came within thirty or forty yards of him, and then delivered the fatal volley which was so ominous a precursor of his determined charge; we cannot suppose, I say, that this British soldier will now knock his knees together, and lose his presence of mind, because he can fire, and be fired at, at longer ranges. It is certain, on the contrary, that the better his weapon, the more he is instructed and practised in the use of it, and the more confidence he acquires in his own powers,—the more likely he will be to retain his wonted self-possession, and to employ his ammunition in a useful manner.

Our instruction system has not yet been satisfactorily tested. When it is so, it is probable that the rifle advocates may be somewhat disappointed in the first instance with the performances even of their best regiments; but it is equally probable that all their reasonable expectations will be fully verified by the performances of veteran troops. Old soldiers, with greater experience, and increased fertility of resource, will, like those hidden Russian sharpshooters before Sebastopol, referred to by the author whom I have quoted, do much in furtherance of that "miserable" species of combat which he so deprecates, and will render life at least uncertain to all those of the hostile forces who are placed uncovered within their reach.

Making liberal allowance for a difference between home and service practice, it is quite clear that our riflemen, who can shoot accurately at 600 yards, and very effectively against large bodies at half a mile, will never be restricted to a range of 400 yards; and it is certain that the improvement of infantry practice in the field will bear some considerable proportion to that which it has made elsewhere. Smoke, and other impediments to aim, will no more disturb the infantry than the artillery. Irregularities of ground, which prevent cavalry or artillery from acting, will favour the operations of infantry skirmishers; whose long ranges, from slightly elevated positions, or from different parts of a hill-side in a broken country, will tell fearfully on their opponent's masses.

Under these circumstances, it is evident that no bodies of cavalry, artillery, or infantry, will in future be safe when they are exposed to the fire of infantry skirmishers armed with the Enfield rifle, or one equal to it, at half a mile; and there seems to be no difficulty, as far as weapons are concerned, in providing our soldiers with rifles that will take effect at much greater distances.

I must next proceed to consider what are the actual, and what the expected, powers of artillery, as compared with the newly-acquired capabilities of this terrible infantry.

Artillery has been truly said to be the chief representative of distant combat, or, in other words, of the "long bowls" that have been so much objected to. Its main duties on the battle-field are to fire, either offensively or defensively, at the enemy's troops—to ruin any defences which they may possess—to cover the deployment, the advance, or the retreat, of cavalry or infantry. It is also the duty of artillery, in some cases, to harass, or, if possible, to silence, the fire of any hostile batteries found to be particularly mischievous, either by direct fire, or, what is better, when it can be effected, by horse artillery acting on their flanks.

The projectiles which have been hitherto employed by artillery are grape, common case or canister, spherical case, shot, and shell.

Grape and common case, consisting of balls secured round a spindle, and balls contained in a tin canister, respectively, and known in French by the common name of "mitraille," are exceedingly destructive at ranges of from 150 to 300 yards; but the balls scatter so widely, that it ceases to be worth while to employ them in the field at ranges greater than 300 or 400 yards.

Spherical case, or Shrapnel, so called from Sir Henry Shrapnel, their inventor, are composed of shells filled with musket balls, and containing a

small charge of powder. The shells are made so thin as to burst with a minimum charge, not dispersing their contents more than can be avoided; but sufficiently thick to resist the force of the explosion by which they are discharged from the piece. In order to produce a good effect, they should burst at a proper elevation, and some 50 or 60 yards in front of the object aimed at. Their ordinary range in the field is from 650 to 1,050 yards; but they are somewhat uncertain in their effects, owing to the difficulty of causing them to burst just in the right place.

Extensive experiments were made at Woolwich in the year 1819, and the result of them is given in the little Hand-Book of Field Artillery, edited by Col. Lefroy, R.A. and published in 1854. There were 1,090 rounds fired altogether; from 3-, 6-, 9-, 12-, 24-pounder guns, an 8-inch howitzer, and a 68-pounder carronade, at ranges varying from 650 to 1,100 yards; and from 12- and 24-pounder howitzers fired at ranges varying from 650 to 1,200 yards. Eighty-three per cent. of the shells took effect, ten per cent. not bursting at all, and seven per cent. bursting at the muzzle. The effect upon the targets was not very encouraging. These were composed of two screens, each 54 feet long and 9 feet high; and one of them was 50 yards behind the other. They were struck by only 35 per cent. of balls, including the splinters of the shells; and, as 30 per cent. of those did not penetrate the targets, it is concluded that they would not have inflicted fatal wounds. The moral effect of spherical case, and of artillery generally, is no doubt considerable; and there have been instances, one of which is quoted by Sir Howard Douglas, in which a fortunate shot with spherical case has proved exceedingly destructive; but the material effects of these missiles is, as I have said, uncertain, and they are expensive to use; and these are the reasons, probably, why they have not been more employed by other nations.

Some ingenious improvements have been made in these shells, as many of my audience are no doubt aware, by Captain Boxer of the Royal Artillery. His fuze, a model of which, from this excellent Museum, is on the table, is more easily applied, and more certain in its effects, than the old one; and a wrought-iron diaphragm, which has been cast inside the shell at his suggestion, is intended to be of use in preventing the powder from being ignited prematurely by the friction of the balls contained in it. The necessity for this latter invention has not, however, been universally admitted; and it does not appear that all the improvement that could be desired has thus actually been effected in the practice of spherical case.

Missiles of an analogous nature, but of a superior character, have been constructed by Sir William Armstrong, and are said to have answered exceedingly well; but there is this difficulty in the application of all such projectiles in the field, that they are required, as I have already stated, to burst at a certain elevation above, and at a given distance in front of, the object aimed at, in order to produce satisfactory results. If the shell bursts too soon the balls are too much, if too late they are not sufficiently, scattered. In order that they may be usefully employed, the range must be acquired with considerable accuracy; and this can only be done, when it has not been previously ascertained, either by the ordinary

means of judging or calculating distance, or else by watching their effects, and adjusting the elevation of the gun, and the time for the fuze, accordingly. At long ranges, or against moving objects, it becomes a difficult matter thus to acquire the range at the moment when it is wanted; and it is not worth while to expend ammunition in this manner, when a greater amount of destructive effect can be produced by solid shot, or by shells not intended to burst. At the same time, the improved case will be very valuable against masses of troops, or the defenders of entrenchments, at long ranges, (when opportunity is afforded for acquiring an accurate idea of the range, either by previous knowledge or by watching the effects of the shells,) up to that point at which the velocity of the contained missiles, after the bursting of the shells, is sufficient to impart to them destructive effects.

The argument hitherto employed on both sides, has been, whether field artillery, with its appliances of grape, common case, and spherical case, can stand its ground against infantry sharpshooters. In considering this question with reference to the means in use up to the present time, it would appear, that, as far as grape and common case are concerned, their random effect, at 500 or 600 yards, against a concentrated and accurate fire of rifle-bullets, and perhaps of explosive rifle-shells, would be practically useless. Shot and shell, or spherical case, at similar, or greater distances, could not do much more against an extended line of skirmishers. The position of many of these would be discovered only by the smoke issuing from their rifles. Some of them would probably be acting on those tender points, the flanks of the guns; and their fire could only be partially subdued, even by the aid of any infantry skirmishers who might be spared specially for the protection of the artillery, or who might be acting with them. It is, of course, assumed that such skirmishers will not expose themselves in swarms to the fire of the artillery. When they are foolish enough to do so, they will no doubt suffer for it; but so long as they adopt the more rational system of extension and concealment, they will afford any uncovered gunners that may be within their reach but little chance against them.

These are highly important questions; but there is a still stronger reason why the grape, canister, and spherical case of field artillery at present employed, should lose ground in the field in future warfare. They were more especially formidable and useful when musketry fire was only available up to 200 yards; but they have now been partially superseded, and it would be unwise to continue to make use, to the same extent, of these more expensive, more cumbrous means of field artillery, when the infantry man with his rifle can in some respects do the work better. It is a question whether the Enfield rifle in the hands of the infantry is not now capable of making a greater proportion of destructive hits between 600 and 1100 yards on a column of men than the artillery with their spherical case; and the infantry might be armed, as we know, with rifles that would enable them to do still more at greater distances, if it were thought desirable so to arm them.

The tables here shown, for which I am indebted to Captain Lempriere, the Instructor of Musketry for the Royal Engineers, give some of

the results of rifle practice. No. 1* conveys statistical information relating to the Hythe practice, and gives the best average performances of individuals and parties under instruction at that establishment. No. 2* shows the per-centage of hits made by the duty men of the Royal Engineers, who practised at Chatham during the past year, for different distances, between 100 and 900 yards. The per-centage of the whole practice is represented by the number 42, while 30 per cent. of hits were made between 600 and 900 yards. It must be remembered that the targets here used were very much smaller than those to which I have previously referred, as having been employed in spherical case practice. They vary in size from 6 feet high by 2 feet wide at 100 yards, up to 16 feet wide by 6 feet high at 900 yards; whereas the artillery targets were four times as long and half as high again—54 feet wide by 9 feet high, and there was one 50 yards behind the other. The riflemen would make, probably, but a small proportion of misses in firing at such targets as those last mentioned.

But further information is required upon these points; and it would be exceedingly desirable to have a trial of skill, under fair conditions, between riflemen and field artillery. They should fire under similar circumstances at similar targets; they should each employ the best means that modern science has placed at their disposal; and the proportionate capabilities and expenditure of the two arms, as deduced from the results of such experiments, would then form a useful guide for determining the relative extent to which, and circumstances under which, they might for the future be usefully employed.

Common case and grape may still be useful for certain purposes, such as the defence of defiles and the ditches of fortified works, and for assisting the action of infantry, when the guns are under cover, at short ranges; and the Armstrong projectiles will no doubt have a more extended application; but, as far as appears at present, further improvements in artillery are hardly likely to restore to these descriptions of projectiles *all* the ground which they have lost. Artillery improvement is moving forward in a different direction. The application to large guns of the principles which have proved so efficacious with the rifled musket, will ensure greater accuracy of practice and increasing ranges to the artillery; and the system of employing aggregated quantities of small random projectiles, for which increased precision, beyond a certain point, is of less value, with a view to their producing chance results by their dispersion, is, in effect, giving way, to a certain extent, before improved conditions, under which, with more accurate weapons, better effects can in many cases be more economically achieved.

Unfortunately, the feeling appears to have been too much entertained in previous discussions of this question, either that field artillery must hold its own against the rifle, or else that the artillery service generally must decline before the progress of that weapon. Having pointed out on the one hand, why the artillery have been in some measure displaced from one set of duties, I would therefore explain how, on the other hand, the balance is restored by other work being provided for them; and how, in fact, there will only be an alteration in, and not at all events a diminution of, their important functions.

* *Vide* infra, pp. 193-4.

In the first place, artillery, and an ample force of improved artillery, will be more than ever required in the field for the attack of posts and positions. When hamlets, country seats, villages, or farms are rendered properly defensible, and when the rifle is judiciously employed for their protection, an assault by daylight, difficult under any circumstances, will now become still more so without a well-sustained fire of artillery. In the prosecution of future sieges, an ample supply of artillery, and improved artillery too, will be required to assist on the part of the attack, in counteracting the advantages which the defence has acquired from the use of the rifled musket. Looking to our national position, and the progress of steam in foreign navies, we shall want guns and gunners in greater numbers for the defence of our coasts. And, lastly, referring to a point which I shall presently introduce to your notice—viz. that the employment of the rifle will lead necessarily to the increased use of entrenchments in field operations—I may here add, that there will be required a plentiful supply of shot and shell fired horizontally to ruin such entrenchments, and of shell and case fired at high angles to drive the defenders from their works; and that without these means, an attack upon such works by day can hardly, under ordinary circumstances, be expected to succeed.

The importance of artillery generally, also, will be much increased by the possession of such guns as are now being provided for them.

As the duties of the artillery will thus necessarily be modified, and as they will be called upon in future, when employed to the best advantage, to act more against standing works, and less against moving masses of men at short ranges, so also they will manœuvre in a somewhat different manner. They will be more stationary than heretofore, and will be better enabled to take advantage of a judicious combination of natural position and artificial protection, to secure them from the effects of their opponents' rifle fire. They will wisely avail themselves of the assistance of the spade, and they may even find it desirable, either to carry with them, or to draw upon occasion from the Engineers' stores, as may be thought best, a supply of suitable mantlets for the protection of the gunners. These have been already much employed, and they will in time become indispensable for guns of position, and for all siege batteries, against an enemy possessing good sharp-shooters, and armed with improved rifles.

I need hardly observe that many of the remarks which I have made are only applicable to such circumstances, and that the employment of artillery against a foe not possessing these superior weapons will be less modified. A noble use of artillery has, for instance, been made by Lord Clyde, during the recent operations in India; and much loss to his infantry has been saved, both by this means and by a judicious application of the Enfield and Lancaster rifles.

As to the assertion that we shall not have rapid or decisive results by playing at "long bowls," I would remind you for a moment—my time will not permit me to do more—of the fact that we are not now beginning to play at long bowls; but that it is a game which has already been played with decisive results for a long time; and that the only difference is this, that, as our weapons improve, we must inevitably proceed to play at "longer bowls" than we did before. Inasmuch as houses, villages, en-

trenchments, and posts, may be more tenaciously defended, so we may expect a corresponding increase of close fighting, in any attacks made in future upon them; but, in the plain, the increased range and accuracy of artillery and musketry fire will produce greater effects, and therefore more decisive results, in a shorter time than before. Excepting in those parts of them where posts and buildings have been defended, great battles have already been principally decided, and will in future be decided to a still greater extent, first, by the amount of destruction caused by the respective fire of the opposing parties, and secondly by the *moral* effect of an advance. Jomini, whose experience was very great, first under Marshal Ney, and afterwards with the Russians, in the early part of the present century, says, "Scarcely anywhere, but in villages or in defiles, have I seen actual conflicts between columns of infantry, the heads of which struggled by the push of bayonets; never in the field of battle have I seen anything like this." David played at long bowls decisively enough against Goliath. Our archers of the 14th century played this game with extraordinary effect. The Battle of Homildon in 1402 against the Scots was won by the archers, while the men-at-arms looked on. At Leipsic, in 1813, there was a noble game at "long bowls." After the Allies had attempted unsuccessfully and with fearful loss, on the 18th of October, to produce decisive results by close attack, they collected 800 guns in a semicircle, and, playing for four hours upon the French, they inflicted losses upon them which compelled their subsequent retreat, and sealed Napoleon's fate. The French columns attempted again and again to move forward against this fearful storm, but they were swept away as often as they advanced; and their most determined efforts were unavailing. With all his disregard for human life, we cannot suppose that Napoleon, when his empire was tottering in the scale, would on this occasion have refrained from employing rifle skirmishers against the allied gunners, instead of sacrificing his devoted columns, if he had been possessed of modern means; or that he would have been prevented from doing so by any consideration of the misfortune that would attend an alteration in the existing relation between the three arms.

With regard to such relation, it is almost needless to observe, in the words of the homely proverb, that we must "cut our coat to suit our cloth." The relative capabilities of the three arms must always determine the relation that will subsist between them, and the only way in which we can alter that relation is by changing those relative capabilities.

Then, again, when it is asserted that the bold bowmen of Cressy and Agincourt would disdain to be associated with modern riflemen, let us remember that these bold bowmen were themselves guilty of shooting the poor Genoese archers at a time when the strings of their cross-bows had been relaxed by the rain, and when they were, therefore, unable to retaliate. If, in times to come, the spirits of the said bowmen should be disposed, as our author seems to anticipate, to reproach our future heroes for cowardly devices—"for displaying their skill," as he says, "in destroying their enemies" with "a minimum amount of danger to themselves,"—the riflemen will be able readily to reply, that the bold bowmen always did much the same, inasmuch as their shafts flew further, and with more effect, than the bolts of their opponents; and, in truth, it is just the principle

thus enunciated which is the foundation of good generalship, and the aim and object of all fortification.

It is highly gratifying to see that our gallant artillery are no more afraid of these deadly riflemen than they have been in past times of any other of their country's enemies; but we must not permit them to engage in so useless and unequal a contest as a duel of spherical or any other case against extended musketry skirmishers. It would be most unwise to do so when they are required for duties of much greater importance, in which we are quite unable to act without their assistance.

Neglecting many points of interest connected with future tactics, to which I had hoped, in preparing this lecture, to be able to refer, I must now pass rapidly on to the next portion of my subject—the influence of the spade upon field operations as they will now necessarily be conducted.

By the spade, as referred to in the title of my lecture, I do not intend to speak of a mere digging instrument; but I refer to it as emblematical of the means by which a soldier may be covered from his enemy, and may have the great advantage of dealing out his sixty rounds of ammunition, or as many as he can usefully employ, from a position of comparative safety. Just as the term crinoline has been accepted by the British public, as indicating the stick-out-a-tiveness of feminine costume, in spite of the probability of crinoline itself in most cases having nothing to do with it, so I would put forward the spade as a generic term for all those contrivances in which it may or may not take part, and which are included under the title of Field Fortification.

The soldiers of ancient, and the knights of mediæval times, protected themselves, as we all know, by means of armour, which they carried on their persons. This at last became so weighty as to leave its bearers, when once they fell, or were overthrown, a helpless, though somewhat difficult, prey to their unarmed foes. But it did not serve, with all its weight and strength, efficiently to protect them against improved weapons, and, as gunpowder came more and more into use, it was finally abandoned.

The shelter that ceased to be available against the weapons of former days, cannot *à fortiori* be usefully employed against those of the present day; and now that armour is more than ever required,—now that it is even wanted to preserve a body of men from the fire of half-a-dozen hidden skirmishers half a mile distant from them, or from the accurate fire of much more distant artillery, it becomes still more difficult, in spite of our improvements in manufacture, to provide any portable means of protection that shall be available for our soldiers in the field. But, as with most other difficulties, so also with this one, there are ample means of meeting it, if we do but look it fairly in the face, and if we properly prepare before hand those requirements which are necessary to enable us to provide against it.

Although our soldiers cannot carry on their persons any armour that would be useful to them against rifle bullets, or, with their impedimenta, any that would avail against artillery shot and shell, yet they may find on every well-selected battle-field, and on almost every position that they can be called upon to occupy, a plentiful supply ready to their hand, if they be but taught to use it, and if they be so placed as to be enabled to take advantage of it. Hedges, walls, banks, woods, undulations of the surface

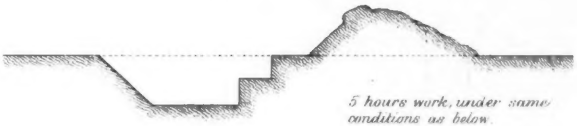
of the ground, may be partly made available, as they have been in former wars, in the state in which they are found; and may often with skill and labour be converted, in a comparatively short period, into works of an importance which in earlier times was better understood, which has of late been too little appreciated, but which, for the future, can hardly be over estimated.

This desirable object cannot, however, be obtained without previous preparation. In order to make the most of natural features, the highest skill must be at hand; in order to improve them during the short time that may intervene between the occupation of a position and the attack of an enemy, an abundant supply of labour must be forthcoming; and in order that that labour may be cheerfully given, and usefully bestowed, sufficient instruction and experience must have been afforded to the military workmen. Besides which, I may add here, that a reasonably liberal allowance of working pay sweetens the labour of the soldier, as well as the labour of any other class of his countrymen.

The detailed principles to be followed in strengthening a battle-field are evidently widely different from those under which works of a more permanent nature are constructed. The main principles, indeed, are the same, in the sense in which Napoleon and other great commanders have said, that "all war should be carried on in accordance with the rules of fortification." But there are clearly important minor distinctions to be kept in view, subject to the discretion of the general and the engineer, in the different cases that arise. In the first place, the more permanent the entrenchment or fortification is intended to be, the more must its facilities for offensive operations be made subservient to its defensive requirements; and, *vice versâ*, the more ephemeral the entrenchment, the more must the defensive works be laid out with a view to offensive movements, to be undertaken by the defenders at the proper moment. Secondly, in the preparation of a battle-field, or in the presence of an enemy, when there may be but little time allowed, before an attack is to be expected, the utmost use must be made of natural features, and the works must be so laid out, in a great measure, as to afford a maximum of advantage from a minimum of labour; while in works that can be more deliberately executed, and in which time is not so much an object, a greater amount of labour may be afforded, and ultimate efficiency be more perfectly attained. In the former of these two cases, more skill and readiness will be required on the part of those who design and superintend the execution of the works, than in the latter, in which more time can be afforded, both for reflection and for labour.

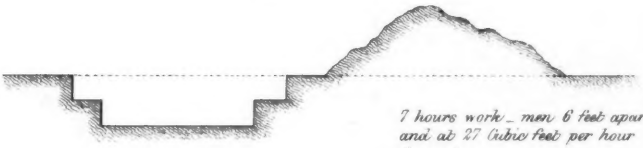
There is this material difference also (arising out of the former of the two considerations thus presented) between the two classes of works to which I have referred. Works of a more permanent character, defended by a smaller garrison, must be made more or less secure against assault, by means of a ditch placed in front of the parapet, and of palisading, abattis, chevaux-de-frize, or any obstructions that may be at hand; as well as by means of a flanking fire, obtained from suitable indentations in the parapets, upon an enemy attempting to pass such obstructions. But impediments of this nature, applied injudiciously to the more ephemeral entrenchments of a battle field, may be productive of much mischief.

Fig. 1.



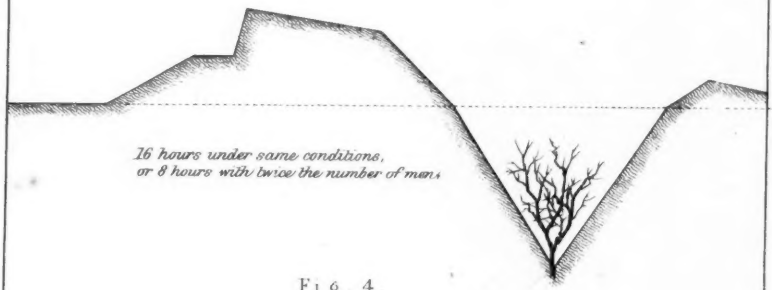
5 hours work, under same conditions as below.

Fig. 2.



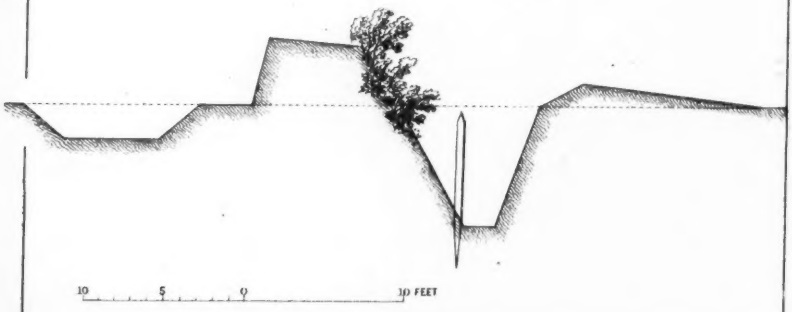
7 hours work — men 6 feet apart, and at 27 cubic feet per hour for each man.

Fig. 3.



16 hours under same conditions, or 8 hours with twice the number of men.

Fig. 4.



J.R Jobbins.

They may be so disposed as to offer an obstruction which is not required, or even shelter, to an attacking enemy, while at the same time they may prevent the troops in their rear from advancing in turn to the attack, or may oblige them to march out through narrow openings, at a time when their assailants have been disordered by their advance, and can be advantageously assaulted.

Such works will, in general, be most useful when they offer no impediment to troops marching over them, when they are entirely open to assault, when they have no indentations in the parapet except such as are required from the nature of the ground, and when they are so disposed as to concentrate their fire upon the approaches in their front, which are available for the advance of the assailants, taking the latter both in front and in flank, when such can conveniently be done. The defenders will not then be hindered in any manœuvres that may be required of them; they will be enabled to utilise their own fire to the utmost, from a position of comparative security; and they will be prepared to step over their parapets, and advance to the charge, in a perfect order of formation, if such should be necessary, or when it might be desirable.

There must, of course, be certain points in almost every position which it is important to entrench more strongly, and to render secure against assault: such as advanced posts, before which it may be desirable to detain the assailants, under a heavy fire, perhaps, from other parts of the field; or posts on the flanks, which it may be necessary to prevent the enemy from getting possession of at all hazards; or decisive points, which may be strengthened without interfering with offensive movements, and the loss of which would endanger the security of the whole position.

The greater the importance of such points or posts, the more strongly, of course, they should be fortified, according to the time and means at the disposal of the engineer; but frequently, the advanced posts, in particular, being placed under an overwhelming fire from other parts of the position, may advantageously be left open to the rear. If closed all round, and made equally strong in one part as in another, or if made too strong in the rear, they may become, when once taken, as great an advantage to the enemy as they were before an obstruction to him; but, if left open towards, or commanded from, the rear, then an enemy may find it impossible to retain them, even after having sustained heavy losses in getting possession of them.

The profiles of battle-field entrenchments, to meet the requirements which I have above indicated, may be constructed as shown in the annexed diagram, figs. 1 and 2 being types of those to be most commonly employed, and figs. 3 and 4 of those in which increased security becomes necessary. They may, in most cases of soil and situation, be executed in a night, and they may often be completed in a few hours, if only there be workmen to construct them, and officers to lay them out, without hesitation or delay, and to superintend their completion.

It will be impossible to give, in the time that is here allowed, the details of such operations. They would be similar to the works already prescribed for siege trenches and field fortifications; and for these I would refer you more particularly to the publications of Captain Macaulay and Colonel Jebb, and to the excellent article by the latter on field fortification in the *Aide*

Mémoire of the Royal Engineers. I may state, however, generally, that about 1000 workmen would be required for every mile of the simpler forms of entrenchments, and that their period of labour would average, in ordinary soil, four or five hours; while a man per lineal yard, and a period of at least eight or ten hours, might be required for more defensible works. The workmen would, of course, be placed in closer proximity where the work was heavier, and further apart where it was less laborious, and such averages must, of course, be taken as subject to great variation. In some cases a hedge-row may be converted into an efficient earthen screen, passable by troops, in a couple of hours; in others, protection may be only inadequately obtained after the hard labour of two reliefs of workmen.

No rules can be laid down, except those contained in the principles above enunciated, for the disposition of such works in plan. That must depend entirely upon the nature of the ground to be defended, and the character and composition of the troops; but the amount of work will be materially increased or diminished according to the judgment with which the entrenchments are laid out on the ground. The selection of the proper portion of a slope, the adoption of a suitable line of hedge, may save the workmen hours of labour, at the same time that it increases the efficiency of the position, though the great point, and that to which all these considerations must be subordinate, is to develope fire upon an advancing enemy.

The temporary parapets or mounds to which I have referred, may the more properly be considered as the armour of the modern soldier, because they are solely intended to shelter him from the enemy's missiles, and have not the effect which fortifications, in the common acceptation of the term, are intended to possess. They are more particularly applicable to the *defensive-offensive*, or *Wellingtonian*, system of operations, as it is termed, to which our great successes have been mainly due, and for which British soldiers have been found, by much experience, to be best adapted; and it is to this system, of which offensive action, assumed at the right moment, is the soul, that my remarks have hitherto been mainly directed. In employing it, the British commanders trusted principally, in the wars at the commencement of the present century, to the cover of natural slopes, and the assistance of any obstacles that presented themselves in the positions they selected, as at Waterloo, for the protection of their men, who were otherwise exposed, for the most part, to the fire of the enemy; and they have only occasionally made use of entrenchments, as at Fuentes d'Onoro, in the manner indicated. They might have done so to a greater extent on many occasions with manifest advantage; and even at Waterloo much loss of life would have been saved, had more sappers, more tools, and an infantry better instructed in, and prepared for, field engineering, been at the disposal of our great commander, during the hours that intervened between the time when the position of Mont St. Jean was first occupied and Napoleon's attack.

It is impossible to read without a feeling of indignation that, though they had plenty of time on the morning of the battle, the little party of heroes at La Haye Sainte were unable to make the most of their position, because their best workmen had been sent to the post of Hougoumont, and

because *the* mule which carried their tools had been lost, so that not even a hatchet was forthcoming in the hour of need.

At Fuentes d'Onoro, as has been recorded by Sir William Reid, entrenchments were thrown up by the Allies on the night of the 5th of May, 1811, after the severe battle of the preceding day; and the support thus afforded to the exposed part of the allied position saved Wellington from further molestation. Massena, who commanded the French, after lingering about the spot for some days, left Almeida to its fate, stating, by way of excuse, that the enemy "had drawn to their assistance all the resources of fortification against an attack by main force."

The Russians have, perhaps, been more remarkable than any other nation for the useful application of temporary entrenchments. The redoubts employed by Peter the Great at the battle of Pultowa, in 1709, enabled him to destroy the prestige which nine years of victory had given to the Swedes, and, thoroughly defeating Charles XII., to prevent him from advancing, as he intended, upon Moscow. A century later, the redans on the left, and the redoubt towards the centre, of the Russian position at Borodino, afforded Kutusoff the means of standing firmly, with an army partly composed of irregular troops and militia, for a whole day, against the veteran army of Napoleon; as well as of inflicting on that army a total loss of killed and wounded greater than he himself received. Within the last few years, also, we have had another remarkable instance of the perseverance of the Russians in, and their adaptation for, this mode of fighting, in the prolonged resistance which they offered to the allied forces of France, England, Turkey, and Sardinia, before Sebastopol.

More permanent works or positions, such as were prepared or occupied, in the defence of Provence by Marshal Berwick, towards the beginning of the eighteenth century; in the defence of Ardennes by General Dumourier, at the head of the Republican army, towards the close of that century; or in the Duke of Wellington's defence of Lisbon, by means of Sir Richard Fletcher's celebrated "Lines" in 1810, hardly come within the scope of our present subject. The position of Bautzen, again, formed during the previous three months, in which, although it was partly turned, the Russians and Prussians withstood for a time, and caused great loss to, an army composed of nearly double their numbers under Napoleon, in 1813, is an instance of more elaborate works, only applicable to special cases; as is also the position of Dresden, carefully prepared, and too long maintained, by Napoleon himself in the same year. The entrenched position at Buntzelwitz, formed during four days (or ten, according to other accounts) by the Prussian engineers, under Frederick the Great, in August, 1761, has been given as one of the most happy instances on record of a combination of art and *coup-d'œil*, and an adaptation of trace and detail to the force and constitution of the army for which it was formed. If prepared for some time before they are required, with the knowledge of the enemy, such works may often be avoided or turned, and thus rendered useless; and, though of great importance under certain circumstances, they can never be capable, like the impromptu entrenchments that have become necessary for the protection of future armies, of universal application.

The latter are analogous, however, to the works carried on by the

assailants during the siege of a fortified place. Here, as well as in minor operations of attack, and even in the field, there are frequent cases in which it is highly important to maintain a post which has been gained, or a position which has been conquered, as a starting-point for ulterior operations. Under these circumstances, entrenchments become most valuable accessories when they can be thrown up on the spur of the moment, either for independent action or for increasing the means of resistance afforded by obstacles already on the spot. It is sometimes of great consequence, also, to be able to reverse, in the shortest possible time, the defences of an enemy's works, captured in the course of an attack, which must be rendered secure before a position can be safely occupied, or before subsequent defeat can be guarded against.

In illustration of the value of experienced or instructed soldiers, under skilful officers, in former wars, I may quote the following instance of what occurred near Bayonne in 1813. I give it in the words of the late lamented Sir William Reid, of the Royal Engineers, from whose valuable paper on "Intrenchments as supports in Battle," (published in the second volume of the old series of the Royal Engineer Professional Papers,) I have derived a part of what I have endeavoured to convey to you on this subject.

Sir William Reid says, "It deserves here to be recorded, that the outposts of the 52nd Regiment had been so well fortified by the late Captain George Barlow, of that regiment, that the pickets had no occasion to retire until they had fired their sixty rounds of ammunition. This officer had taught himself how to strengthen posts by barricades and other temporary expedients; and he deserved the support he always received from the Engineers, who supplied him with what he required from their small dépôt"—may we have no more *small* dépôts!—"of entrenching tools. The pickets being thus enabled to hold their ground, without risk, for a considerable time, the troops for the defence of the main central position had full time to assemble (for it was in December, and they were scattered in houses), and to deploy in the position, the greater part somewhat retired behind the slope of the ground. There was nothing in the defences which impeded the usual formation, and everything was prepared to maintain this ground offensively."

The experiences of former warfare are exceedingly valuable as guides and beacons; but they only feebly indicate the requirements which will evidently be demanded in future combats. Infantry and artillery fire have now acquired a fearful increase of power, and it seems probable, that entrenchments, instead of being useful auxiliaries, to be employed occasionally, will eventually become a main feature, even of operations conducted in the open field. When an enemy is near at hand, all the exposed outposts of an army will require to be protected; and masses of infantry and cavalry must, as well as artillery, be placed under artificial shelter, whenever their position will allow the enemy's skirmishers to approach in sight, within half a mile of them, or the enemy's artillery within two or three times that distance. Every post must be entrenched which it is of importance to defend; and no time must be lost in entrenching a position taken from an enemy which it is intended to maintain.

The Roman legionaries were employed to fortify their camps with a

rampart some 12 feet high and 12 feet or more wide, armed with strong palisades, and with a ditch of corresponding dimensions in its front; and it is estimated by Gibbon that a Roman camp for 20,000 men would be about 700 yards square, and would therefore contain 2,800 running yards of rampart. Works of similar magnitude will be required for the protection of future armies: although modern skill will be better able to dispose its parapets, and will not in most cases demand, for temporary purposes, so much earthwork per running yard, yet still greater extension in length may often be necessary, and all the available labour of an army will not be too much for the performance of such works as it will be desirable to execute in the time that can be allowed for them.

Here, then, we have an evident want. It is clear that the lives of our soldiers, and the efficiency of our armies, will much depend, in future, upon the means that they may possess of entrenching themselves. The principles upon which they must do it are tolerably well known. They were stated by that master in tactics, Frederick the Great; and they have been more or less enunciated by our greatest engineers, our gallant Chairman, the late Sir John Jones, and Sir William Reid, among the number. The details for carrying out those principles, as applicable to analogous operations, have been practically worked out and published by Sir Charles Pasley and Colonel Jebb, and the writings of the former have served as a guide for, so-called, more warlike nations, as well as for our own service. But sufficient means of instruction has not yet been afforded to the officers who may command our future armies, or to the men who will compose them, either fully to appreciate the importance of these things, or to prepare for the new requirements that are dawning upon us.

I say sufficient means of instruction to our officers and men has not been afforded, because I know well that nothing more is required. There is no deficiency of zeal in the mass of our army, any more than amongst Englishmen of any other class. No pains will be wanting on their part, to perfect themselves in that which they see to be necessary to their efficiency, when proper opportunities are placed within their reach.

If we were *now* called upon to take the field, our army would not be composed of officers and men so skilled and practised in such operations as to be enabled to derive the greatest advantage from them; but there can be no good reason why this should be so. There is nothing abstruse in the science of field engineering; no difficulty in teaching it or learning it. It has been proved by the Engineer rifle practice, that the man who is taught to dig does not shoot worse than the man who is more exclusively trained to the use of the rifle. An infantry officer who is also a field engineer, will post his men at least as judiciously, and will lead them quite as bravely, as any other, while commanding them with greater confidence in his own resources, and possessing more moral influence over them. The best infantry that a nation could now possess, would be one in which every man was not only an efficient rifleman, but also a well-trained sapper, and in which every officer was a field engineer; and there can be no doubt that an infantry of this description, supported by a proper proportion of the other branches, is the army that is now required "to go anywhere and do anything."

The number of our Sappers, too, is very small considering the amount

of work that will evidently be required of them, either in the field or in siege operations. Three thousand rank and file, besides five hundred in India, are the total number provided for the corps in the Army Estimates recently laid before Parliament; and, looking to the multifarious duties that are required of these men in all quarters of the world, it will be seen that only a portion of them is available for active operations at any one particular point. Now that science and "industry" are tending more and more to take the place of "vive force," it will no doubt be found necessary to augment that number very considerably, however much the soldiers of the line may improve in the practice of field engineering. Indeed the two must naturally advance together, because the more the infantry become useful in these respects, the more will they demand superintendence, assistance, and attendance, from the special corps; and the latter will be more than ever required to carry on with promptitude those works for which they are more particularly adapted; including the laying down of telegraphs, the construction of bridges, the art of photography; and extending from the survey of a country to the sketch of a camp, from the construction of a railway to the repair of a shovel, from the entrenchment of a position to the digging of a rifle-pit.

But, besides the question to which I have been referring, of providing earthen shelter for him, or rather teaching him to provide it for himself, there are other matters of equipment and preparation which must be carefully considered with reference to the altered position of our infantry soldier, if we wish to raise him to the highest degree of efficiency.

Napoleon has observed that two-thirds of the strength of an army depends upon moral influence; and all history has confirmed the assertion. Let us take the instance of Pultowa above referred to. Before that battle, 8,000 Swedes had, as Voltaire observes, destroyed ten times their number of Russians in an entrenched camp at Narva, and 18,000 of them would have attacked the whole force of Russia, and would have perished to a man rather than have surrendered. After that battle, their prestige gone, their king, whom they had hitherto regarded as invincible, wounded, and absent, they gave themselves up in masses to their pursuers.

Now, moral influence, as here employed, is nothing more than a conscious or assumed superiority on the one side, opposed to a conviction of inferiority on the other; and it is a quality which can and ought to be cultivated, by the improvement of the soldier's intellectual and physical condition. To the natural steadiness and determination of the British soldier, ought to be added that self-confidence which arises from experienced fertility of resource; and the feeling of superiority, in which the Anglo-Saxon is sufficiently inclined to indulge, ought to be strengthened and justified by improved general intelligence, as well as by increased proficiency in those offensive and defensive arts which are necessary to his profession.

One of Colonel Jacob's opponents, writing in the *United Service Journal* under the signature, before referred to, of "A Field Officer of Artillery," attempts to turn him into ridicule, for linking improved rifles and educated soldiers together, and for supposing that there is any necessary connection between the two; but it is now placed beyond a doubt, by the light of experience, that, up to a certain point, increased intelligence actually produces better shooting. Indeed, it has even been urged on the other hand, and with

better reason, that the want of sufficient intelligence in the soldier will be an impediment in the way of his making the best use of the most perfect weapons; and that therefore it is not desirable to furnish him with the best rifles that can be made. One reply may, however, be made to both of these statements. It is alike possible and desirable, by a judicious system of education, and particularly of professional education, to increase the intelligence of the soldier; his learning to shoot alone will increase his intelligence to some extent; the more his intelligence is increased in other ways, the better, up to a certain point, will his shooting become; and, in proportion as his intelligence and his good shooting progress together, in the same proportion will his value be augmented for the service of his country.

The time has gone by when it could be seriously discussed whether an indifferent class of men did not make the best soldiers, and whether the subordination of the soldier, so necessary to military discipline, would not be injured by increasing his intelligence, and his means of forming a judgment on the measures of his superiors. If that were true, the men of the Royal Engineers ought to be the most insubordinate, and the most difficult to command, in the service, instead of being, as they are, men who will turn their hand to anything that may be required of them, in peace or in war, under fire or under water, in strict obedience to the orders of their officers. Education is fortunately now on the increase in the army generally; and we shall not look in vain for a good result, when it shall have been fully brought to bear; but, in the meantime, the great want that appears to exist, is in this matter of field engineering. We have got instructors of musketry: would it not be desirable also to have instructors of field engineering, either combined with that office, or distinct from it, as may be thought best?

A great deal has been said from time to time about the dress of the British soldier; and this is a subject, no doubt, of increased importance in connection with the accuracy and range of infantry fire. In reference to it I should be glad to draw attention to the tables here shown,* which I have extracted from a valuable little work by Colonel Le Couteur, the Adjutant-General of the Royal Jersey Militia. Colonel Le Couteur deduced these tables from experiments made with pieces of cloth stretched upon a frame, which he observed at various distances, and in different states of the atmosphere. As far as his experiments go, the result appears to be, that we need have no apprehension as to any necessity for abandoning our national colour. It has the great advantages—now more than ever essential—of enabling British troops to recognize each other with readiness, of being imposing in appearance, of exhibiting a less ghastly appearance than most other colours on wounded men. It is the proud emblem of many a hard-fought field, and many a well-earned victory; and, whilst it is the most distinct colour, next to white, at short distances of 300 yards or so, in a clear, bright state of the atmosphere, it is, at the same time, not so well seen as white, blue, rifle-green, or stone-colour, under less favourable circumstances of light and distance. I may observe, however, that these results are materially affected by differences of position and background.

* *Vide* p. 192.

I should also be glad, before I conclude, to say a very few words on that portion of the much-vexed question of national defence which is immediately connected with our present subject.

Our position in this respect, in the middle of the nineteenth century, is in painful and discreditable contrast with that of our ancestors. Four or five hundred years since, it was the fashion for English kings and princes to lead small armies across the water, and to defeat, as at Cresy, Poictiers, and Agincourt, any number of foreign troops that could be brought against them. In the present day, we ourselves indulge in periodical panics, apprehensive lest our gallant allies should take it into their heads to cross the Channel, without giving us time to prepare a fitting reception for them; and what is the cause of the contrast thus presented?

The application of steam to vessels of war, while operating for the most part to our advantage, has partially bridged the Channel, and has rendered the passage of it more easy than it was before, in the event of our fleets being engaged in other duties than that of guarding our coasts. Our neighbours are now in possession of fleets and armies, too numerous to be intended solely for defensive purposes, and far too highly organized to justify any feeling of security on our parts, so long as we remain unarmed, or only partially prepared for resistance. But English soldiers have not become less valorous, nor have French ones surpassed them, individually, either in bravery or efficiency. The principal reasons for this contrast, as far as we ourselves are concerned, may be combined in a sentence, composed—first, of the words of the old writer, who said, "The might of the realm of England standyth upon archers;" and, secondly, of the opposite truth, in which it may now be justly alleged, that "the weakness of Great Britain lieth under a want of riflemen."

In former days, the practice of archery was enforced by law; at present, rifle practice is not encouraged. In those days every householder, who did not supply his children and his servants, between the ages of seven and seventeen years, with a bow and two arrows, was fined 6*s.* 8*d.* a month. The practice of archery was then universally enforced; restraints were laid upon other games that were likely to interfere with the use of the bow; and Englishmen of full growth and maturity, were prohibited from firing at a mark less distant than 120 yards. In these days, we are only beginning to avail ourselves of the advantages to be derived from a school of musketry, and proficiency in the ordinary weapon of the soldier is limited to a number insufficient for the defence of the country.

We have no desire to emulate the aggressive spirit of the times referred to, but we should at least secure our own shores, and our own hearths, from the possibility of insult. We can do so with little trouble, and at a cost from which we ought not for a moment to shrink. The rifle increases the power of the defensive element in field operations enormously; and trained riflemen, when placed behind entrenchments, are not inferior to regular troops. I do not advocate what is called putting the rifle into the hands of the people; but I assume that a hundred thousand volunteer riflemen might, without difficulty, be selected from a class of men who would be ever ready to protect us, alike from foreign invasion or from internal disturbance. A sufficient number of sappers to provide entrenchments, in suitable positions, for the action of such

volunteers, would now be of inestimable value for all other military operations. The volunteer sharpshooters would harass the flanks and rear of the invader, and would also be enabled to aid the regular troops and militia, in disputing the country, mile by mile, with any foreign army that could in the first instance be brought into it, in a manner that would render advance impossible.

If the Thames were protected, and the great arsenals and dockyards of the country secured from sudden attack, by fortifications adapted to the circumstances of modern weapons; and if, in addition to our smaller force of regular troops and militia, of artillery and infantry, volunteer riflemen and sappers were available for action in sufficient numbers on the shortest notice; we should then not only be enabled to feel a security which we do not now possess, but we should also assume an attitude of defence that would of itself go very far towards preventing any serious contemplation of hostile invasion. We should also be at liberty to employ considerable portions of our fleets upon such distant duties as might be urgently required of them, in maintaining our naval supremacy in every part of the globe, instead of being obliged to collect them in the greatest possible number, in feverish anxiety, for the vital object of defending our coasts.

Such is a brief sketch of the system of national defence which appears to be suited to the requirements of the present time. Railways and telegraphs, rifled muskets and rifled cannon, ready means of intrenchment and revised systems of fortification, well-trained officers and intelligent soldiers, are our modern means and appliances. With diligent preparation, and a right use of them, we may defy aggression, and, by God's blessing, we may confidently expect to carry high the banner of our country through any future contests in which we may be called upon to participate. Without such diligent preparation, and without present judicious expenditure, we must ever feel anxiety and uncertainty as to the issue of our first operations; however great the confidence with which we all look forward to ultimate success.

If we may judge by what is said and written, there would appear, however, to be much misapprehension in the public mind as to the fitness of this country for defence in its present state. The popular idea is, that the fences with which it abounds would be all in our favour, and that our skirmishers would have a simple duty to perform, in picking off their enemies from behind them. It is for the most part forgotten, that the invaders would find shelter as well as our own men; and that our hedgerows, by covering the advance of, and affording protection and support to, a hostile force, would, in their present condition, be quite as useful to our enemies as to ourselves.

The front of a position selected for defence, like the glacis of a fortress, should afford a minimum of shelter, in order that the fire of its defenders may tell to the utmost upon their assailants. In preparing a position for an engagement, therefore, in this country, more would have to be thrown down than built up; much judgment would have to be exercised, alike in the one case and in the other; and now that artillery and musketry fire are becoming more destructive, and shelter more important, officers and soldiers well trained as field engineers will be most urgently required.

It becomes desirable now to sum up, in conclusion, the changes that may be anticipated in future field operations, in consequence of improved shooting on the part of the soldier and the artillerist; the influence that such changes may be expected to produce upon the success of our arms; and the means by which they may be best turned to our advantage.

In the first place, we may take it for granted, and, whatever we may desire, we must accept it as a fact, that small-arms fire will eventually be enabled to produce destructive effects at ranges five or six times as great as those at which the musket of former times was properly used, when hostile forces, armed with the best weapons now supplied to the soldier, are in sight of each other; that artillery fire will be employed, when the ground will admit of it, at increased ranges; and, what is still more important, that it will be served with greatly increased precision. We may confidently expect, not only that the fire of skirmishers will be more effective, but also that it will, in consequence of its increased range, and its vast powers of destruction, when employed against troops in any sort of close order, supersede to a certain extent the present grape and case shot of field artillery, on the one hand; while, by its powers, when employed against uncovered guns, it will in some measure serve to prevent their action on the other. We can foresee that the field artillery service must therefore undergo a considerable change; and that it must now be more particularly perfected, by the aid of its newly acquired powers, with a view to its producing accurate effects, at longer ranges, with shot, shell, and case, against masses of troops, against an enemy's guns, or against parapets, buildings, works, and obstacles of whatever description, behind which an enemy may find shelter.

It is probable, that, though skirmishers will be employed to act against skirmishers, yet they will only be able to afford partial protection to the armies to which they may respectively belong. As it has been the general rule hitherto, in the service of field artillery, that it should be employed principally in firing at an enemy's masses rather than at his guns, so also skirmishers will be employed on both sides to the greatest advantage in future, when they conceal their own persons by natural or artificial means, and direct their rifles principally against the larger bodies of their enemies; and we may expect that they will to a great extent adopt this system of operation.

Concentrating in this manner a vast amount of accurate fire against an enemy's field artillery, to which, with its only partially divergent, and, under such circumstances, comparatively random, fire, it will be but ill able to reply, they will produce effects upon it which it will be unable, at ranges of 600 yards or so, to withstand, and which will compel it to act, when uncovered, from greater distances. Turning their weapons against an enemy's cavalry, they will without difficulty compel it, either to advance or to retire, if it have been injudiciously placed within their reach. The skirmishers on either side will, in fact, become so formidable, and will, seconded by the far-ranging power of more distant field-artillery, have the power of producing such deadly effects upon the masses of infantry, upon the cavalry, and upon the field-artillery of their opponents, that when hostile armies approach each other in future, they will be compelled, instead of sleeping within 1000 or 1500 yards of each other, as on the night which

preceded the Battle of Waterloo, to maintain a more respectful distance; and, at all events in the case of an invading army amongst a hostile population, to shelter themselves behind the best combination of natural and artificial cover that they can procure, as the only means of avoiding continual annoyance and gradual annihilation.

Such being the tendency of the newly-acquired means of offensive operation, it is evident that defensive measures, superior to any that have hitherto been employed, become, not only desirable, but absolutely necessary; and that that army which can cover itself most quickly, and most effectually, in taking up a new position in the face of an enemy, will possess an advantage second only to the employment of superior offensive weapons.

It will be conceded without hesitation, that the greater advantage to be derived from this increased power of the infantry soldier's fire will lie with those troops who are best adapted, by their natural capabilities, for acting in extended formations.

As an attack upon troops in position by troops in column will be more hazardous than it was before, and as any exposed deployment within 800 yards of such weapons will be attended with great loss, so those men who can stand longest, and with the greatest steadiness, against an advancing enemy, in that two-deep order which is best fitted for the developement of their fire, must have a greater superiority than ever over any opponents who do not possess a similar amount of natural "*impulsion*." And, as the individual confidence of the Anglo-Saxon soldier is greater than that of the soldier of any other nation, so we have a fair right to conclude, that if he be provided with the best weapons, instructed in the best manner, and protected by earthen armour, when occasion requires, on the shortest notice, he will not only be willing, but will also be well able, to cope with superior numbers of any other troops with which he may be brought in contact.

Superiority in rifle fire, from large and small guns, is now, as archery was in former days, the first desideratum for affording our soldiers the advantage in the day of battle; and superiority in field engineering, on the part of our commanders, subordinate officers, and soldiers, becomes for the future only second to it in importance. In the former we may fairly hope to rival any other troops that we can have to encounter, from whatever part of the globe, if we only cast off all prejudice, and if, making proper use of the national wealth, the mechanical skill, and the means of manufacture which we possess, we adopt those rifled weapons, whether Lancaster, Enfield, Armstrong, or Whitworth, or any other, which, upon fair trial, are proved to be best suited to the various requirements of the soldier and the artillerist. In the latter we are miserably deficient. Our sappers are comparatively few in number; our infantry are in a great measure uninstructed in that which is so necessary to their future safety. Article 56 of the Queen's Regulations clearly recognises the want in terminating with these words: "the use of the spade, pickaxe, and barrow, is as essential for the defensive, as that of the musket and bayonet is for the offensive, operations of the army." But no adequate steps are being taken to further or facilitate the carrying out in practice of the wise maxim here so well enunciated. We have not yet, unfortunately, had the wisdom to discern, or at all events fully to appreciate,

through the haze under which improvement marches rapidly onward, and in which future requirements are shrouded, that the only antidote to, and the necessary attendant on, the growing perfection of rifled arms, is that one of the arts of the sapper which may easily be taught, in which a large proportion of our troops ought to be thoroughly instructed, and which is not I think inappropriately represented under the emblem of the *Spade*.

COLONEL LE COUTEUR'S EXPERIMENTS for testing the RELATIVE DISTINCTNESS of COLOURED CLOTHS at DIFFERENT DISTANCES.

	From 300 yards.		From Half-a-Mile on a clear day.	From One Mile on a clear day.	From Half-a-Mile and One Mile on a dull cloudy day.
	At day-break of a clear day.	At 10 A.M. of a clear day.			
White . . .	1	1	1	1	1
Blue . . .	2	3	2	2	2
Rifle Green . .	3	5	3	3	3
Stone Colour . .	4	8	5	4	4
Red . . .	5	2	4	5	5
Austrian Blue . .	8	4	7	6	7
Grey . . .	7	7	6	7	6
Brown (fern) . .	6	6	8	8	8

N.B. These results depend much upon the positions of the objects observed, and upon the background against which they are seen; and the brightness or dulness of the red employed, will have much to do with the distinctness of the colour.

TABLE No. 1.

STATISTICAL INFORMATION having reference to RIFLE INSTRUCTION.

Classes and Distances at which they fire.		No. of Targets Fired at (each Target being 6ft. high by 2ft. wide, and representing one man).	Rounds Fired at each Distance.	Greatest No. of Points obtained by any Individual at the Several Distances.		Greatest No. of Points obtained by an Individual in the Several Classes.		Greatest Average Points obtained by any Single Party at the Several Distances.		Greatest per centage of Hits obtained by any Single Party at the Several Distances.		Greatest Average Points obtained by any Single Party in the Several Classes.		Greatest Mean Average Points of any Year's Performances at the Several Distances.
				Officers.	Soldiers.	Officers.	Soldiers.	Officers.	Soldiers.	Officers.	Soldiers.	Officers.	Soldiers.	
	yards													
3rd class	100	1	4	10	12	39	35	5·88	7·00	89·28	94·44	21·60	22·88	5·29
	150			9	11			5·55	5·71	75·00	83·33			3·64
	200			9	10			4·33	5·53	69·44	80·55			2·82
	250	2		9	9			5·00	5·25	84·37	90·00			3·20
	300			8	9			4·14	4·22	77·77	78·57			2·54
2nd class	350	3	3	5	6	20	20	2·35	2·60	66·66	70·58	11·00	15·66	1·83
	400			5	6			2·13	2·33	59·25	64·44			1·63
	450	4		4	5			2·25	2·25	63·88	63·88			1·31
	500			5	6			1·73	1·94	57·40	57·77			1·18
	550	5		4	5			1·90	1·90	60·00	60·00			1·07
	600		5	6	6			2·36	2·50	50·00	72·00			1·52
1st class	650	6	3	4	5	13	15	2·25	2·25	58·33	58·33	6·30	8·50	1·05
	700			4	6			1·57	1·75	37·50	47·61			1·00
	750	7		4	5			1·50	1·50	41·66	41·66			0·74
	800			3	5			1·50	1·50	48·66	48·66			0·76
	850	8		4	5			1·20	1·20	36·66	36·66			0·57
	900			3	6			1·42	1·42	20·00	20·00			0·64

TABLE No. 2.

ROYAL ENGINEERS.—PRACTICE of DUTY MEN at HEAD QUARTERS, CHATHAM, for the year 1858-9, with the LANCASTER RIFLE.

Distance.	Percentage of Hits.	Distance.	Percentage of Hits.	Distance.	Percentage of Hits.
100 yards . . .	78·78	400 yards . .	47·34	700 yards . .	36·27
150 „ . . .	60·91	450 „ . . .	36·37	750 „ . . .	24·14
200 „ . . .	42·68	500 „ . . .	49·29	800 „ . . .	29·65
250 „ . . .	60·62	550 „ . . .	38·92	850 „ . . .	21·25
300 „ . . .	49·74	600 „ . . .	34·82	900 „ . . .	25·47
350 „ . . .	51·58	650 „ . . .	39·03		

SIR JOHN BURGOYNE.—Captain Tyler has given us a very interesting lecture upon a very interesting subject.

It is evident that the general introduction of the rifle into the service, and the greatly increased power that is rapidly being developed by means of rifled cannon, will require much alteration in the system of warfare, which will not be fully understood until after much studied consideration given to the subject, and much practice, and even experience in actual war.

Captain Tyler is early in the field of research, and has submitted many valuable observations as a commencement.

I will on this occasion only allude to one, which is the great necessity that will arise for troops to procure cover from the deadly aim of these perfect weapons, even at great distances; natural cover will be sought for with more eagerness and judgment, and greater efforts will be made to obtain artificial cover by spade and pickaxe: there is one great difficulty, however, with regard to the latter that will be much felt in the field, in the scarcity of the necessary tools and implements: Captain Tyler expresses a hope that hereafter this scarcity may cease; and I join him most cordially in that hope, but I fear we can hardly expect it in any very essential degree. The soldier clearly cannot carry them himself, and army transport is usually under the greatest pressure for provisions, forage, ammunition, and other objects of still greater need than tools; the only remedy will be increased instruction to the soldier to enable him to turn his scanty means to the best account; and every encouragement to be given to him to use more exertions in the labour of field work than has hitherto been habitual to him.

The whole resolves itself into what is becoming more and more apparent, that the soldier's is becoming every day more a skilled profession, and the well-practised soldier of increasing value over the raw recruit.

With regard to the effect of the introduction of these great improvements in warlike implements, *we* have no reason to fear the consequences.

The British soldier was pre-eminent in old times in the use of the bow. He has since then been as superior with the bayonet, and we have no reason to fear but that he will shine equally with the rifle!

I will conclude with proposing the cordial thanks of the meeting to Captain Tyler for his able and interesting Lecture.

Thursday, May 12th, 1859.

Lieut.-General the Hon. Sir EDWARD CUST, K.C.B., in the Chair.

ON NAPOLEON'S CAMPAIGN IN ITALY IN 1796.

By Colonel MACDOUGAL,
Commandant, Royal Staff College, Sandhurst.

I HAVE selected, as the subject of this Lecture, Napoleon's campaign in Italy in 1796, as being of peculiar interest at the present moment, on account of the resemblance which exists between some of its earlier scenes and those now being enacted on the same theatre. It is very remarkable to observe how, after a lapse of many years, the same military events reproduce themselves, so that hostile armies are found to occupy the same, or very nearly the same, positions as those which were chosen by the armies of former generations; and how it even happens that the contending parties fight on the very same battle-fields as have been moistened by the blood of their forefathers. A very short consideration however may convince us that this resemblance is a matter of necessity, since it arises from the natural physical features of the country, which do not change, such as the direction of the great rivers and mountain ranges, and the fertility or the barrenness of the different districts. These are the conditions which determine the choice and direction of military lines of operation, and even in many cases point out the exact spots where decisive engagements will be fought. Hence it arises, at this moment, that the eyes of Europe have been fixed with interest and expectation on the battle-field of Marengo, where the first Napoleon won his brilliant victory over the Austrian General Beaulieu, as being the probable scene of another great battle; and hence it arises, also, that the positions which are occupied now by the Austrians on the north bank of the Po are very nearly the same as those which Beaulieu occupied during the second part of the campaign of 1796.

In 1792 the war of the first coalition against France commenced, and I must refer you to general history for the military events of that year, and of the succeeding years, previous to 1796; indeed, the campaign of 1796 itself was of such extent and duration that it would be impossible, within moderate limits, to give any detail of all the operations. I must limit myself to treating them very much in a general way, selecting, however, two of the principal operations for relation in detail. I allude to the movements which preceded the battle of Montenotte and to those in the second part of the campaign which preceded the passage of the Po by Napoleon at Piacenza.

In the year 1796 the King of Sardinia was allied with Austria and England against France. The line of demarcation which separated the Austrians and Sardinians on the one hand and the French forces on the other was divided into two distinct parts; one, formed by the western

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In the year 1796 the King of Sardinia was allied with Austria and England against France. The line of demarcation which separated the Austrians and Sardinians on the one hand and the French forces on the other was divided into two distinct parts; one, formed by the western

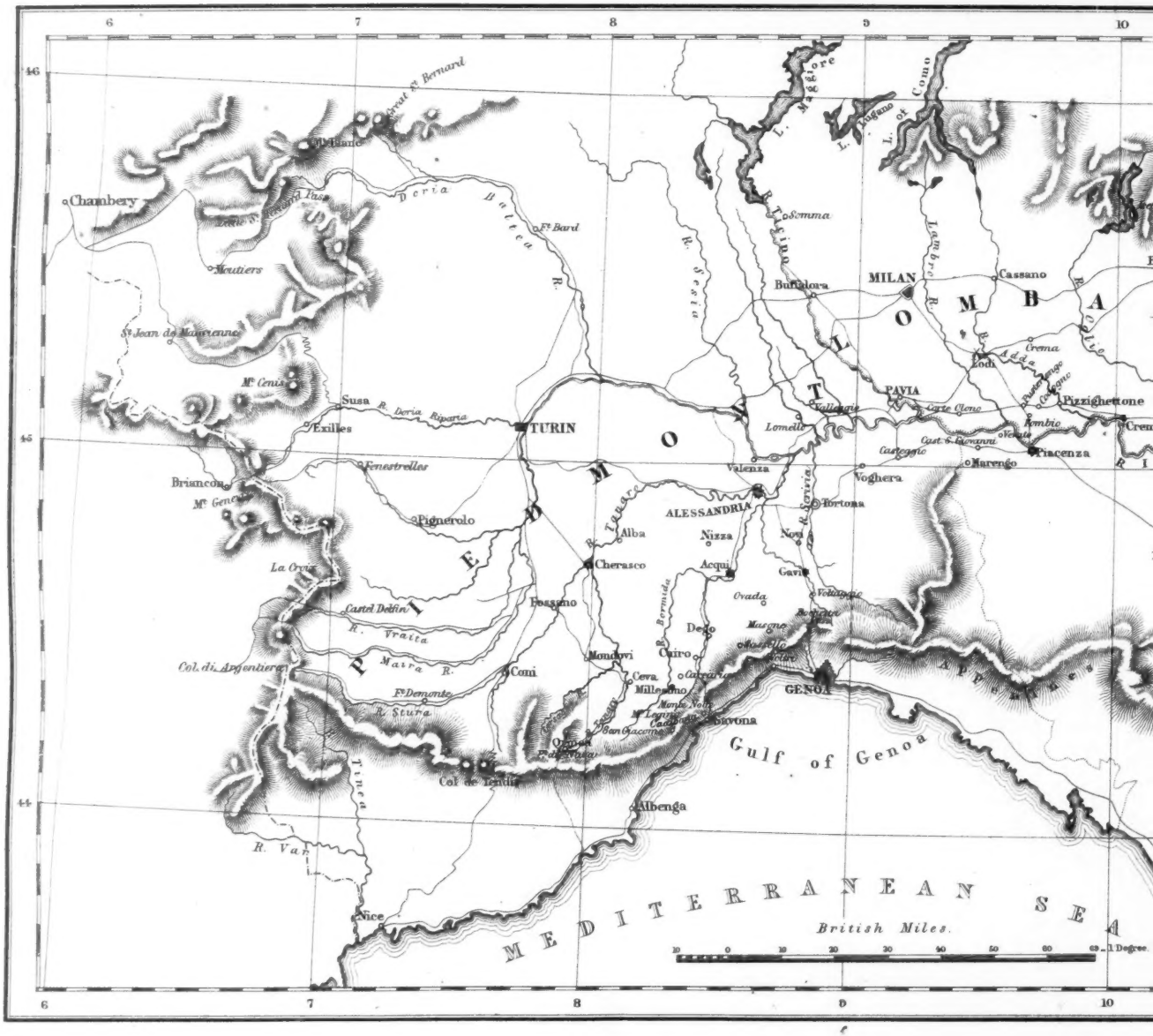
chain of the Alps from the Little St. Bernard on the north to the Col di Argentiera on the south, was guarded by a French force of 20,000 men, called the Army of the Alps, under General Kellerman; the other portion, extending from the Col di Argentiera on the left, and along the crest of the mountains to Montenotte on the right, was guarded by the Army of Italy, commanded by Napoleon himself. But it is easy to perceive the disadvantage which resulted to the French from occupying so extended a line. The different French corps, placed on the summits of the mountains, could only communicate with each other by a long march, which would occupy twenty days; while their enemies, situated within the concavity of that vast circumference, and able to march between any two points by the shortest possible line, *i.e.*, on the chord of the arc, could throw themselves in force upon any point which they might desire either to attack or to defend, in a far shorter time than the French would require to concentrate their forces at the same point. The French also suffered great hardships in obtaining supplies, arising from the badness of the mountain-roads, while their enemies in Piedmont were easily supplied with food and other requisites; and to these disadvantages must be added those of climate, for the French, posted on the mountains, lost as many men in the course of three months by sickness as would have been lost in a general action.

Now, to penetrate into Piedmont, over the western barrier, the French army must march by one of the five passes, the names of which are Argentiera, La Croix, Mont Genevre, Mont Cenis, or the Little St. Bernard. An army passing over the Col di Argentiera would descend upon Turin by one of the three valleys, viz., the Stura, the Maira, and the Vraita, guarded respectively by the forts of Demonte, Genola, and Castel Delfin. An army passing over the Col de la Croix would penetrate into Piedmont, and descend upon Turin by one of the two valleys of St. Martin or Pragelato, guarded respectively by the forts of Pignerolo and Fenestrelles. An army operating from Briançon would pass over Mont Genevre, and descend upon Turin by the valley of Pragelato, or by the valley of the Doria Riparia, guarded by Exilles and Susa. An army coming from St. Jean de Maurienne would march over Mont Cenis, and descend into Piedmont by the valley of Susa. This is the route which the French troops have now taken; they have crossed Mont Cenis, descending upon Turin by detachments. An army operating from Moutiers would cross the Little St. Bernard mountain, and descend into Italy by the Doria Baltea valley, guarded by the little fort of Bard, which so nearly rendered abortive Napoleon's famous campaign of Marengo.

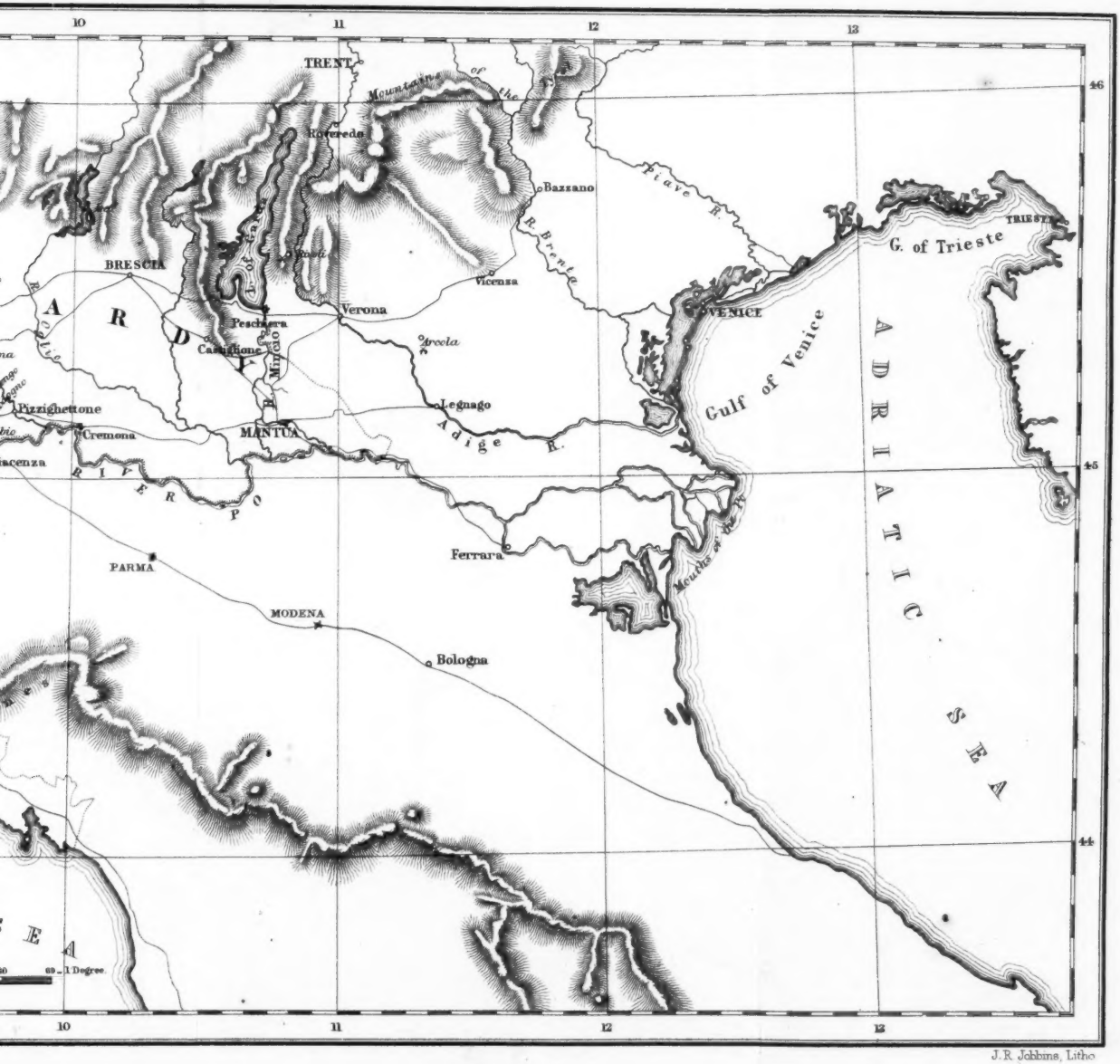
To enter Piedmont, over the southern barrier, from Nice, four passes were at that time practicable for an invading army—First. The Col di Tenda, guarded immediately by the fortress of Coni, leading by Fossano and Cherasco, on to Turin. Secondly. By the Ponte di Nava, leading by Ormea, Ceva, Cherasco, also on Turin. This entry is defended by the fort of Ormea and the citadel of Ceva, but Ormea was in possession of the French. Thirdly. By the Col di Cadibona, leading by Cairo, and Acqui, on Alessandria. Acqui was a fortified town, and Alessandria was a first-class fortress. Fourthly. By the Bocchetta pass, leading by the fortified town of Gavi to Tortona.

At the commencement of the campaign, Napoleon's only line of com-

MAP TO ILLUSTRATE THE FRENCH CA



ENCH CAMPAIGN IN ITALY IN 1796.



J.R. Jobbins, Litho

munication with France lay through Nice. Nice is upon the coast line, and Napoleon's immediate base of operations may be considered to have been the strip of country, inclosed by the mountains on the one hand and the sea on the other, between Nice and Savona.

The English had the command of the sea, and the French, therefore, could not make use of it as a means of transport. The troops which Napoleon found at his disposition amounted to about 40,000 men, consisting of four divisions of infantry and two divisions of cavalry. Besides these, two brigades guarded the passes of Tenda on the left leading to Turin, and two divisions guarded the coast road from Nice to Turin.

Napoleon, on his arrival at the seat of war, found the army in a complete state of destitution with regard to food, clothing, transport, and supplies of every description. His troops were very much in arrears of pay, and he had no money wherewith to pay them; and there was great disorganisation and relaxation of discipline, as is always the case under similar circumstances. The first care of Napoleon was to provide for the immediate wants of his army, and to restore order amongst them; next to inspire his troops with an ardent desire to engage the enemy, by appealing to their national love of glory, and by convincing them that the only hope of any improvement in their condition lay in a victorious advance against the enemy. It was, indeed, impossible to remain stationary. Napoleon's resolution was taken to advance, to surprise the enemy by the rapidity of his movements, and to put in practice his favourite maxim, "que la guerre nourrit la guerre,"—meaning that war should be self-supporting. On the very day of his arriving at head-quarters, which was on the 27th of March, he issued the following order to his troops: "Soldiers, you are naked and starving; the government is much in your debt, but has nothing to give you. The patience and courage which you have displayed on these desert rocks are admirable. But these qualities are unable to procure you any glory so long as you remain here. I am about to lead you into the most fertile plains in the world. Rich provinces and great cities will be your prize. You will find in that rich country glory, honour, and wealth. Soldiers of Italy, you will not be wanting in either courage or constancy."

But it was easier to talk of leading his army to the conquest of Italy than to place it in a condition which could alone render that conquest possible.

Having succeeded in persuading a rich contractor to advance a large sum of money, the interval between the 25th of March, when he arrived, and the 9th of April, was incessantly occupied by him in re-organising his army, and bringing them out of the state of chaos into which they had fallen. His labours will be found detailed in the first volume of his Correspondence, which has been published lately by order of the present Emperor of the French. This correspondence is extremely interesting, and furnishes a proof, as indeed do the general orders of the Duke of Wellington and of all great commanders, how small is the proportion of the time and attention of a general which is occupied with the mere arrangements for fighting alone. Napoleon had to busy himself with the actual purchase of supplies of food, forage, and clothing, and particularly shoes; to procure military supplies of every description, and to store them in the different towns along the coast for the immediate consumption of his

army. He had to purchase horses and mules, and to create a transport train for the purpose of conveying supplies to his troops; and in this he was so successful that before the 5th of April his army was in a completely efficient condition, and he had inspired his troops with that enthusiasm and confidence in their commander which are such powerful contributors towards victory.

I will now turn to the positions which were occupied by the Sardinians and Austrians in Piedmont. On the extreme right a Sardinian force of 20,000 men, under the Prince of Carignano, guarded the passages into Piedmont from the western range of mountains, and was therefore immediately opposite to, and in observation of, the French army under Kellerman. The principal army of the coalition, consisting of a combined force of Austrians and Sardinians under the chief command of the Austrian general Beaulieu, was posted immediately opposite to the army of Italy, and was thus distributed:—The Sardinian portion of that army consisted of 20,000 men and 60 guns, commanded by General Colli. It had its head quarters at Ceva, but it was too much disseminated, since its general line extended from the valley of the Stura on the right to Millesimo on the left. It therefore had not that power of rapid concentration on any one point that it ought to have had. The Austrian portion of this army consisted of 40,000 men and 140 guns. Its right wing was at Sassello, under General Argenteau; and its left wing, divided between Voltaggio and Ovada, was commanded by Beaulieu in person. Thus we may consider that General Colli commanded the right, Argenteau the centre, and General Beaulieu the left of the combined force. Now this extended position occupied by his enemies suggested to Napoleon the following plan of operations: viz. to mass the greater part of his army on its extreme right, to pass the mountains by the Cadibona pass, and to overwhelm the Austrian centre before it could be joined either from the right or the left, then, turning suddenly upon the Sardinians, to compel them to conclude with him a separate peace in order to preserve their capital. Savona, a fortified sea-port, was a convenient place to serve as a depôt. From Savona to Madona the distance was four miles, over a carriage-road; from Madona over the mountains to Carcaria was seven miles, by a road which might be made, without much labour, practicable for artillery; and from Carcaria there were carriage-roads leading to the interior of Piedmont. The point at which the Alps and the Apennines join is the only one at which one can descend into the plains of Italy without finding intercepting mountains. So slight are the elevations that Napoleon projected a canal for the purpose of joining the Adriatic with the Mediterranean, by way of the Tanaro and Bormida rivers, it being designed to carry the canal over the mountains by means of a system of locks. On the 5th of April, having issued one of those electrifying addresses to his army which he knew how to employ to such good purpose, Napoleon moved his head-quarters from Nice to Albenga, and on the 9th to Savona, marching with his long train of artillery and engineer equipage by the then horrible Corniche road, in some cases almost within range of the guns of the English cruisers.

On the 9th of April, in preparation for his intended attack on the enemy's centre, the disposition of the French troops was as follows: two brigades guarded the pass of Tenda, and prevented the enemy from operating by

that pass to cut off the French communication with Nice. The division of General Serrurier was in the valley of the Tanaro, covering by his position the pass of Ponte di Nava, which also led upon Nice; and further it had this effect, that it occupied the attention of General Colli, and prevented him from detaching any large number of men to support the Austrian centre. Passing on to the French right, the division of General Augereau was at San Giacomo, and that of Masenna at Cadibona. From these places paths led over the mountains into the same valley as that in which Carcaria was situated. The division of General La Harpe was between Savona and Genoa. In order to render the attack on the enemy's centre more certain of success, it was necessary to divert the attention of the Austrian General Beaulieu from that point to some other. The centre was the point which Napoleon intended to attack, and he employed artifice to make Beaulieu believe that it was the Austrian left which he intended to attack, by forcing a passage through Genoa and marching by the Bocchetta pass and Gavi. Genoa, an independent republic, was in that dangerous and humiliating position in which weak and neutral states between two powerful belligerents must always find themselves placed. The neutrality of its port had been already violated by the English cruisers, and she was unable to protect herself from a similar insult on the land side. The artifice resorted to by Napoleon was this: he instructed the French envoy at Genoa to demand from the senate a contribution of 20,000,000 francs, and at the same time that the Genoese fortress of Gavi should be delivered up to the French; and, in order to enforce compliance with these demands, and to confirm the Austrian general in his belief that it was the Austrian left which was threatened by the French, one brigade of General La Harpe's division, under General Cervoni, was advanced to Voltri—Napoleon foreseeing the possibility that the Austrians from Sassello might make an attempt to march by Montenotte on Savona, and so cut off the French line of communication with Nice as soon as they believed him to be committed in a general advance upon Genoa, secured that passage by the construction of three redoubts on Monte Legino, a buttress shooting out from the main ridge and sloping gradually down towards Savona. The defence of these redoubts was entrusted to a detachment of La Harpe's division, commanded by Colonel Rampon; and on the gallant defence made by that detachment in those redoubts the whole of the subsequent operations hinged. In technical language, therefore, that point would be termed the decisive strategical point of the operations.

The Austrian General Beaulieu no sooner learned that the French had demanded the surrender of Gavi, and that the brigade of Cervoni had advanced to Voltri, than he formed his counterplan, in the execution of which his left was ordered to advance on Voltri; the centre under Argenteau was at the same time ordered to advance from Sassello, by Montenotte on Savona, and so cut off the French line of communication with Nice, hoping thus to inclose the French army between the Austrian centre and the left. In the execution of this plan, on the morning of the 10th of April, the Austrian left marched towards Voltri. The centre, under Argenteau, marched from Sassello and encamped that night at Montenotte. The leading columns of Beaulieu in the afternoon attacked Cervoni's

brigade behind Voltri; but the French held their ground, and retired after dusk to a stronger position in the rear. The position then of the Austrians on the night of the 10th of April was this: The centre had advanced from Sassello and bivouacked at Montenotte. The left had advanced upon Voltri; part of it was at Voltri, and the other part was marching towards that place. On the morning of the 11th, Argenteau, advancing from Montenotte on Savona, found his progress barred by the redoubts on Monte Legino; the Austrians attacked the redoubts at noon, and the contest was continued from noon until dusk, unsuccessfully on the part of the Austrians. General Argenteau drew off his men and bivouacked in front of the redoubts, with the design of renewing the contest on the following morning, taking the precaution, however, to detach one battalion to Ferrania in the valley behind to secure his right flank and rear. During the same day, Beaulieu attacked Cervoni at Voltri a second time, but the French held their ground.

Napoleon, now learning by the reports which he received from Colonel Rampon in one direction, and from Cervoni in the other, that the Austrian centre and left were attacking the French from two different directions, and that they could not communicate with each other, without marching over the bodies of the French troops interposed between them, prepared to strike his blows with that force and rapidity which so eminently characterised him. But Rampon had been hard pressed during the day, and all depended upon his holding his ground. The dispositions of Napoleon, and the movements which, in obedience to them, took place during the night of the 11th, were these: La Harpe was withdrawn from his position between Savona and Voltri, and sent to reinforce Rampon at Monte Legino. The brigade of Cervoni was ordered to fall back secretly during the night from before Beaulieu, and to join La Harpe's division, to which it belonged. This was effected, and before daybreak the whole of La Harpe's division was drawn up behind the contested redoubts. In another direction, during the night, Massena marched from Cadibona, and Augereau from San Giacomo, and uniting near Ferrania, overwhelmed the Austrian battalion, which had arrived there only a few hours before, and continuing their march by Lower Montenotte, ascended the heights behind the Austrian General Argenteau. Napoleon personally directed this movement. Thus, before daybreak on the 12th of April, Napoleon had succeeded in concentrating three of his divisions against the Austrian centre, and in cutting off that centre from all possibility of communicating with its right or left. The Sardinian army, forming the right, was held in check by a far inferior French force under Serrurier in the valley of the Tanaro, while Beaulieu at Voltri was held in check by the phantom of Cervoni, whom he believed to be still in his front, as well as by his general ignorance of the movements of the enemy. On the morning of the 12th, when day broke, the Austrian General Argenteau was astonished to find La Harpe's division drawn up behind the redoubts. La Harpe lost no time in attacking; and while the Austrians were hotly engaged with him in their front, Napoleon led up the divisions of Massena and Augereau, which he hurled against their rear. The corps of Argenteau was completely broken up. It suffered a most severe loss; and, the only road by which it could retreat being in the hands of the French, it was compelled to disperse over the

mountains, and finally the broken remnants of Argenteau's corps rallied at Dego. While this combat was going forward, Beaulieu, still at Voltri, advanced to attack Cervoni, who had retreated for the third time; but, finding no enemy in his front, and uncertain what to do, he remained stationary.

After the battle of Montenotte the positions which the different French divisions occupied on the night of the 12th were as follow:—The division of La Harpe was between Cairo and Dego; the division of Massena was advanced to Cairo; the division of Augereau was at Millesimo, where a detachment of Sardinians held the heights. Thus the mass of the French army was interposed between the Sardinians and their Austrian allies.

Early on the morning of the 13th Augereau, having bivouacked in front of the Sardinians, attacked them at Millesimo, defeated them, and compelled them to retire towards Ceva. It was only in the afternoon of the 13th that Beaulieu, still at Voltri, learned that his centre had been almost destroyed at Montenotte on the preceding day, and that there were hardly any Austrian troops to oppose the advance of the French troops upon Milan. It was necessary, therefore, at once to withdraw his left from its false position at Voltri, and he immediately ordered a concentration of his forces at Dego, hoping still to be in time to forestall the French at that place, but he was too late. At Dego the broken remnants of Argenteau's corps, which had been defeated at Montenotte, were joined by a part only of Beaulieu's left. During the night, or early on the morning of the 14th, the divisions of La Harpe and Massena attacked the Austrians at Dego, defeated them, and drove them back to Acqui, on the road to Milan. Beaulieu, on hearing of this fresh disaster, gave orders for the concentration of his army at Acqui. The Sardinians drew together at Ceva; thus the separation of the Austrians and the Sardinians became irremediable.

While Beaulieu, at Acqui, was occupied in reorganising the remnant of his force, Napoleon turned his whole attention against the Sardinians at Ceva, and leaving one brigade under Victor at Cairo to guard the communication with Savona from the attacks of the Austrians, he concentrated the rest of his troops round Ceva. It is unnecessary to enter into the details; it will be sufficient to say that the Sardinians were driven successively from their position at Ceva, and from that which they occupied subsequently behind the Corsaglia river, as well as from the position of Mondovi, on the 18th and 22nd of April, and were obliged to retreat towards Turin.

Hitherto, it had been necessary to preserve the communication of the French army with Nice by the circuitous route of Savona, but as soon as the Sardinians retired from Ceva, it became possible to adopt a far shorter line to Nice by the Ponte di Nava pass. The French army advanced in pursuit of the Sardinians, and on the 23rd of April Napoleon received overtures of peace from General Colli. Napoleon's reply was that France was as desirous of peace as Piedmont, but, inasmuch as any treaty which he might enter into must be ratified at Paris, he would consent to an armistice, on condition that the three fortresses of Alessandria, Tortona, and Coni, together with the citadel of Ceva, should be delivered up to him, as he could not be expected to consent to lose the fruits of all his victories without some material guarantee. But, as time was all important, he

continued his advance upon Turin while waiting for the acceptance of his proposal. It was, indeed, not to be expected that the Austrians at Acqui could remain passive spectators of the march of their common enemy upon the capital of their ally; but Beaulieu did linger so long at Acqui, that the movement which he at length made for the purpose of joining the Sardinians was too late to be of any use.

On the 25th of April the French troops occupied Fossano, Cherasco, and Alba. One division was on the right in observation of Beaulieu towards Acqui. The acquisition of Cherasco was of great importance to Napoleon, as it gave him possession of a fortified place, which, by means of its own magazines, he could place in a complete state of defence. The position of the French army at Cherasco enabled them still further to shorten their line of communication with France, by adopting the more direct route of the pass of Tenda. On the 25th of April, Beaulieu did at last make up his mind to endeavour to join the Sardinians, and he marched for that purpose as far as Nizza, en route to Alba, but he was too late. On the 26th, the French troops crossed the Stura, and continued their advance upon Turin. On the 27th the Sardinian General Colli signified to Napoleon the acceptance by the Court of Turin of his proposal for an armistice. On the 28th was concluded the armistice of Cherasco, which terminated the first part of the campaign of 1796.

In considering these operations, two capital faults were committed by Beaulieu. First, the advance of the Austrian centre and left to Montenotte and Voltri respectively was at variance with all military principles; because those two portions of the Austrian army were debarred from all commmunication with each other by the French troops interposed between them, and in consequence of the absence of communication they could not concert a simultaneous attack. If Beaulieu's scheme failed, then in order to restore the communication between his left and centre, his left must retrace its steps by the circuitous route of Bocchetta and Masone, and, long before it could arrive to the support of its centre, that centre might be overwhelmed, as indeed it was, by the superior numbers of the French. Had it been possible for Beaulieu to receive correct information of the real state of affairs; that is to say, had he known that his centre was in danger of being surrounded and destroyed, and that only one French division, instead of all the French army, as he supposed, was between him and Savona, he would have forced his way on the night of the 11th at all hazards, and following La Harpe, he might have arrived at the scene of battle on Monte Legino in sufficient time to turn the scale against the French: or, failing that, he might have seized Savona, which would have interrupted the French communications with Nice, in which case prudence would have obliged Napoleon to regain his communication with that place as speedily as possible; but in war the absence of correct information cannot be compensated by any superiority of force.

The other serious fault committed by Beaulieu, was in delaying to join the Sardinians when they were retreating on their capital. The combat at Dego was fought, and the retreat of the Austrians to Acqui took place, on the 14th of April; the French did not enter Cherasco until the 25th, eleven days later. If Beaulieu had united every available man of his own

force with that of Colli behind the Stura, so late as the 24th, he would still have been in time. If compelled to abandon the line of the Stura and to retreat upon Turin, the advance of Napoleon should have been disputed inch by inch, and as they approached that capital a rapid march of the Sardinian force of 20,000 men, commanded by Prince Carignano, to join Beaulieu and Colli, must have sufficed to crush the French. If Beaulieu had thus acted, although he might have failed to protect Turin, he would still, in all probability, have preserved his ally; and the Piedmontese fortresses, in place of serving as so many strong points of support for the French line of operations, subsequently, on Milan and Mantua, would have continued to hold hostile garrisons, the reduction of which would have occupied Napoleon sufficiently long to give time for the arrival of Austrian reinforcements.

The advantages which the French obtained by the Treaty of Cherasco were as follow:—First, they were dis-embarrassed of the Sardinians; Secondly, they obtained the fortresses of Alessandria, Tortona, and Coni, and the citadel of Ceva, which served to strengthen their base of operations, for their contemplated advance on Milan and Mantua; Thirdly, they were enabled to shorten their line of communication with France by one-half, in accordance with the provisions of the treaty. Instead of proceeding by the circuitous route of Tenda and Nice, it now became direct by Susa and Mont Cenis to Chambery—the advantage of which may be appreciated by this consideration; the battle of Millesimo took place on the 13th of April, and the armistice of Cherasco was not concluded until the 28th, fifteen days later: yet Murat, who was despatched with the provisions of the Treaty of Cherasco, arrived in Paris before Junot, who was sent off directly after the battle of Millesimo.

Napoleon's plan was now to drive the Austrians out of Lombardy and across the Adige, and to take up himself a defensive position on that river, which would afford him an intermediate base for future operations against the Austrians, and at the same time cover his conquests in the rear, and his line of communication with France. It is true that the Adige was a long way from France, and it may appear more than probable that, if the French met with any serious reverses in that forward position, the Treaty of Cherasco would have been looked upon by the King of Sardinia as so much waste paper, and the retreat of the French would have been anything but secure. The answer to this objection is that, however hostile in feeling, the Sardinians retained little power of serious annoyance. With their principal fortresses in the hands of the French, the others dismantled, and their levies disbanded, their discontent need occasion no more apprehension to Napoleon than the rattle of a snake that has lost its sting. Piedmont was under the heel of the conqueror. At this juncture the immediate object of the Austrians was to cover Milan. The Mincio may be regarded as their base. If compelled to abandon Milan they had the choice of two roads by which to retreat—one by Pizzighettone and Cremona on Mantua, the other by Lodi, Crema, and Brescia on Peschiera. If they were intercepted on both of those lines, they might still retreat to the mountains of the Tyrol. In this respect they had a great strategical advantage.

Napoleon's general plan of establishing himself on the Adige was divided into two acts: the first was to march on Milan and to organise Lombardy in the French interest; the second was to advance to the Adige. In the execution of the first part of the plan, viz., the march on Milan, the River Po must be crossed, either in the face of the enemy or by deceiving him, and surprising a passage at some unguarded point. In operating from Alessandria the shortest route to Milan was to cross the Po somewhere in the neighbourhood of Valenza; but the road from Valenza to Milan was crossed by several deep and rapid Alpine streams, the principal of which was the Ticino, which would afford the Austrians so many strong positions in which the advance of the French on the capital of Lombardy might be succesively disputed. Immediately after the conclusion of the Treaty of Cherasco the Austrians withdrew across the River Po at Valenza, breaking down the bridge at that place.

On the 5th of May the French head quarters were at Tortona, and the different divisions of the French Army were thus disposed: Serrurier's division was on the left, between Alessandria and Valenza; the division of Massena was at the confluence of the Tanaro with the Po; the division of General Augereau was at the confluence of the Scrivia with the Po. They had received orders to collect together all the boats that could be obtained at those points, as if for the purpose of crossing the Po. The division of La Harpe was at Voghera. These dispositions convinced the Austrian commander that the French attempt to pass the river would be made somewhere between Valenza and the mouth of the Scrivia river; and his measures to oppose it were as follow:—The head quarters of Beaulieu, with two divisions, were at Valeggio; the advanced guard of the Austrian army was at Lomello; one brigade was at Sommo; the division of Liptay was on the left bank of the Ticino, observing the Po in front; the Sardinian General Colli, who after the armistice of Cherasco entered the Austrian service, commanded another division at Buffalora.

Napoleon had secretly assembled on the 5th a picked force of 3,000 grenadiers, 1,500 cavalry, and 24 guns at Casteggio, which he designed to form the advanced guard of his army in his intended attack on Piacenza, and the command of this force was given to General Dallemagne. I should have stated that Napoleon in the Treaty of Cherasco had inserted an express condition that the French army should have a right of passage across the Po at Valenza. This condition was inserted expressly for the purpose of misleading Beaulieu, and making him believe that the French intended to pass the river at that point, whereas Napoleon had determined to make a rapid march to his right to Piacenza while the attention of Beaulieu was directed to Valenza, and while his jealousy of that place was further confirmed by the assemblage of the different French divisions in its neighbourhood. He accordingly assembled the advanced guard at Casteggio. Staff officers were sent off, with small escorts of cavalry, to scour the banks of the river, and to collect all the boats that could be found at Piacenza for the passage of the army. On the morning of the 6th of May the movement commenced. The advanced guard under General Dallemagne, accompanied by Napoleon, made a forced march to Castel San Giovanni. During that afternoon and the succeeding night the remaining divisions of the French army broke up from their positions

along the river front, and followed the advanced guard by forced marches, with the exception of the division of Serruier, which was left between Alessandria and Valenza both to attract the attention of Beaulieu and to guard the French communications.

On the morning of the 7th of May, at 9 o'clock, the movement having commenced on the 6th, Napoleon, with the advanced guard, arrived at Piacenza. The enemy was taken completely by surprise ; he had only two squadrons of hussars on the opposite bank to dispute the passage of the French. The regular ferry boat of the town, together with ten large boats which had been seized, sufficed to carry over 900 men at once, and by two o'clock on that day the whole of the advanced guard stood on the north bank of the Po, and a bridge was commenced in their rear. During the afternoon and the evening the divisions of La Harpe and Augereau arrived respectively at Piacenza and Veratto, and immediately began to cross. While they are engaged in this operation, and while the division of Massena is advancing with all possible speed towards Piacenza, I will turn from them to look after the Austrians.

It was only on the morning of the 7th, the movements of which day on the part of the French I have just related, and about the time when the French advanced guard was approaching Piacenza, that the Austrian General, Beaulieu, was informed of the movement of his enemy, and discovered that his own defensive measures opposite to Valenza were useless. He immediately sent orders to General Liptay at Pavia, to hasten to take post between the rivers Lembro and Adda, in order to protect the Austrian line of communication by Pizzighettone and Cremona. The two divisions at Valeggio quitted that place and followed Liptay. The advanced guard at Lomello was ordered to follow the remainder of the army. About midnight on the night of the 7th, General Liptay, coming from Pavia, arrived at Fombio, and he immediately began to fortify the village by loop-holing the houses, barricading the streets, and planting cannon to sweep the approaches. Beaulieu, with one division, encamped that night at Corte Olono; one division of the Austrian army was left at Pavia, and the advanced guard from Lomello was retreating on Pavia.

Early in the morning of the 8th the advanced guard of the French, under Dallemagne, which had crossed the Po on the previous day, advanced to Fombio, and found that village full of Austrian troops. The position of the French was now critical ; it was necessary to dislodge the Austrians from the village at once—a few hours delay might bring up Beaulieu with reinforcements, and the small portion of the French army at that time across the Po would have been exposed to fight a battle, with a great river in their rear, without a bridge by which to retreat in case of necessity.

Napoleon accordingly reinforced his advanced guard with every man who had already crossed the river, and Fombio was carried after an obstinate resistance. General Liptay retreated to Codogno, but, pursued to that place, he continued his retreat to the Adda, and crossed that river at Pizzighettone, where he remained. During the afternoon of the 8th both the divisions of La Harpe and Augereau succeeded in crossing the river; La Harpe was advanced towards Pizzighettone. During the night of the 8th, at about 12 o'clock, Beaulieu arrived at Pusterlengo. He first

there learned the events of the preceding day, and found that Codogno was in possession of the French, who were thus directly interposed between him and Liptay at Pizzighettone. He took advantage of the darkness of the night to endeavour to force a passage. The French at first were surprised, and their General, La Harpe, was slain ; but the French fought so obstinately that Beaulieu, unable to force a passage, retreated on the road to Lodi, and he ordered the other divisions of the Austrian army likewise to direct their march upon that place.

During the night of the 8th Massena likewise effected the passage of his division across the Po, and, on the morning of the 9th, the whole of the French army, with the exception of Serrurier's division, was on the north bank of the Po, and the bridge at Piacenza was completed, which secured Napoleon's retreat. On the morning of the 9th the aspect of affairs was as follows :—Beaulieu, with the head-quarters of the Austrian army, was retreating towards Lodi from Pusterlengo; two other divisions of the Austrian army were marching from Pavia to Lodi. The divisions of Massena and Augereau were advancing in pursuit of Beaulieu. One French division remained at Pusterlengo to guard the French retreat on Piacenza, and to observe the Austrians at Pizzighettone. Serrurier was approaching Piacenza. On the morning of the 10th he arrived at Piacenza, and filed across the bridge. He then advanced to Pusterlengo, and relieved the French division which had occupied that place. That division was enabled, therefore, to follow the division of Massena and Augereau. Those three divisions were delayed sufficiently long by the resistance offered by the Austrian rear-guard to enable Beaulieu to reach Lodi with his division, and to cross the river, as well as the two Austrian divisions which were marching from Pavia; but it was so near a thing, that the last division of the two was only filing across the bridge when the French entered the town. The results of the battle of Lodi are probably familiar to you all, and I need not, therefore, dwell upon them in detail. Beaulieu, now cut off from Milan, was retreating upon the Mincio, and his only object in defending the passage of the Adda at Lodi was to enable the Sardinian general Colli, with his division, and coming from Buffalora, to cross the river at Cassano and gain Brescia; and Napoleon's only object in endeavouring to force the passage of the river at Lodi was to cut off Colli from Brescia. This may be said to terminate the second part of the campaign of 1796. The Dukes of Parma and Modena now concluded a convention with Napoleon, and a new element was introduced by him into the practice of forced contributions, viz. the exaction of their choicest works of art for the purpose of embellishing the capital of the French republic.

The interval between the 10th of May and the 22nd was occupied by Napoleon in organising Lombardy on the model of the great French republic.

On the 22nd May the French army commenced its march towards the Adige; the Austrians defended the line of the Mincio, and their position was very strong. Their right rested on Lake Garda, and was defended by a flotilla of gun boats on that lake. Their left rested on the Po; their front was covered by the Mincio, and strengthened by the fortresses of Peschiera and Mantua.

Nevertheless, on the 30th of May the French forced the centre of the Austrian position at Valeggio, and the Austrians under Beaulieu retreated into the Tyrol. Thus terminated the third part of the campaign.

The succeeding month of June was occupied by Napoleon in securing his right flank; and the siege of Mantua was now undertaken by the French. They occupied Verona and Legnago on the Adige, the first possessing three stone bridges over the river, and the last one. Napoleon's object was to secure the right flank of his army from the hostile action of the southern States of Italy, particularly Rome. The French troops now occupied Bologna and Ferrara, and one division, marching through Tuscany, threatened Rome. His Holiness, alarmed, sued for peace, and concluded a convention with Napoleon, by which he bound himself to pay the French 21,000,000 of francs, and to furnish large supplies of horses and provisions to the army, as well as to yield up one hundred of his choicest works of art. It is remarkable that one of the conditions of this treaty was, that the French should have the right of garrisoning Ancona; and latterly some newspapers have expressed surprise that the Austrians should now have gone to Ancona. But the explanation of that measure is, that whoever holds Ancona cuts off the communication by the eastern coast, between Northern and Southern Italy.

On the 29th of June the Austrian army, now under the command of Wurmser, was assembled at Trent, and numbered 65,000 men. It advanced from Trent in two columns: one marched by the Adige, 45,000 strong, commanded by Wurmser in person; the other column, consisting of 20,000 under General Quasdanowich, marched by the western shore of Lake Garda—their design was to unite south of Lake Garda, and, when united, to march to relieve Mantua. But the fatal error of the Austrian plan of operations on this as on all other occasions was, that they advanced to their object by different columns, on different lines of operation, between which no communication could exist. The communication between those two Austrian corps was prevented by Lake Garda, while Napoleon, on the south of that lake, could concentrate his whole force at any point; and he made good use of his central position, first, to attack and destroy the corps of Quasdonowich, and afterwards to turn fiercely upon Wurmser, and defeat him at Castiglione. Wurmser retreated into the Tyrol, and thus ended the fourth part of the campaign.

The Austrians and the French now received reinforcements. Wurmser's plan, in accordance with directions from Vienna, was to descend the Brenta River with one column from Trent, and march by Vicenza and Verona to raise the siege of Mantua. Another column was to march from Trent by the country between Lake Garda and the Adige. This attempt also failed in consequence of the adoption of a double line of operations by the Austrians. No sooner did Wurmser quit Trent and commit himself upon his march down the Brenta than Napoleon directed the mass of his force against Davidowich at Roveredo, and drove him back beyond Trent. Then, leaving one division to observe him, he followed Wurmser down the Brenta, overtook and defeated him at Bassano, and drove him in the direction of Vicenza; and here he would have been completely destroyed, but that the French garrison of Legnago, owing to some misconception, had withdrawn, and Wurmser was enabled to cross the river Adige in

safety and take refuge in Mantua. The Austrians now had one marshal and 24,000 men inclosed in Mantua. This terminated the fifth part of the campaign.

The sixth part of the campaign commenced in this way. On the 1st of November the Austrian Marshal Alvinzi with 40,000 men advanced from the Piave river towards the Adige, while another column under Davidowich, consisting of 18,000 men, advanced from Trent; and here was the error again repeated of a double line of operations. 24,000 Austrians were blockaded in Mantua. Napoleon had only 30,000 men at his disposal: 8,000 were blockading the Austrians in Mantua; and he could not raise the siege of that place, as, by so doing, he would have set free 24,000 men. He therefore was obliged to blockade it. With 18,000 he endeavoured to cover Verona from the advance of Alvinzi, while 4,000 guarded the approach from the Tyrol in the strong position of Rivoli. By the victory of Arcola he rid himself of Alvinzi, and terminated the sixth part of the campaign.

Early in January of the succeeding year a third attempt was made by Alvinzi to relieve Mantua on two lines. The principal attack was made by Alvinzi from Trent upon Rivoli. A secondary attack was made by Provera from the Brenta upon the Adige. Napoleon employed a small force to defend the passage of the Adige against Provera, while he concentrated the greater part of his troops against Alvinzi, whom he defeated at Rivoli; and the memorable victory of Rivoli terminated the seventh part of the campaign. As the consequence of this victory Mantua fell; and the campaign of 1796 may be considered to have been terminated by that event.

CHAIRMAN.—I think we can have but one feeling of regret, and that is, that the time has not been a little longer. We must all of us, I think, have been struck with this fact, viz. how thorough a master of the subject our friend is, and how clearly he has described to us military operations of excessive complication, but which, I am quite sure, have been made to the minds of all of you as clear as possible.

Friday, May 27th, 1859.

Colonel the Hon. JAMES LINDSAY in the Chair.

THE APPLICATION OF STATISTICS TO NAVAL AND MILITARY MATTERS.

By W. Farr, Esq., M.D., F.R.S., &c.

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§ I.

If a discovery is made in chemistry—if a new power, such as steam, is created—if new arms are invented—if new systems of preserving health are discovered—military science naturally endeavours to turn them to account; and often succeeds to an extent which the inventors never anticipated.

It was, I apprehend, from a belief that the field of statistics might contain materials of value in a military point of view, that the Council of this admirable Institution requested me to deliver a lecture. And I hope to be able to show that, however wrong they were in the choice of a lecturer, they were right in the selection of a subject.

Statistics is almost a new science. Its name is scarcely understood; yet it has been prosecuted diligently for many years. A great number of facts has been collected, and new methods of inquiry have been instituted. The Census supplies information about the population of these islands in the present time; and thus it furnishes some indications of the resources and the strength of England. The wealth of the country—its sinews of war—has also been investigated. The means of determining the loss of life under different circumstances are known; and many of the causes of sickness and of death are understood. Financial statistics, and all the methods of estimating and of checking expenditure, have made immense progress since the last great French war.

Numbers enter largely into the striking results of war; they run through all its combinations; victory, liberty, the happiness of families, and the fate of nations, often depend upon subtle calculations.

I propose to pass rapidly in review some statistical facts, which may probably be turned to account by some of you, in increasing the power and in developing the defences of this country.

Military statistics deal with the sea and the land forces. The land force consists of the standing army, in the first place; and, in the second, of the yeomanry, militia, and volunteers, which may be either a regularly disciplined force, or a large temporary levy of the fighting men of the nation.

Adam Smith, in one of the ablest chapters of the "Wealth of Nations,"* shows that "a well-regulated standing army is superior to every militia." And, undoubtedly, if the choice lay between these two institutions, it must fall on the standing army; to which the facts I shall have to discuss will refer. But the two systems of defence are required; and the utility of the combination of a standing army—of a military profession—with a well-organised militia, is established by experience, and by the highest military authorities. By the combination, many of the advantages of both the systems are realised, and the evils of a large standing army are avoided. The militia is, says Jomini, the auxiliary of the army on great occasions; and this simple institution, which places all the fighting men of a nation in local reserves, and in battalions ready organised, partly trained, and acquainted with the use of arms, admitting of development in proportion to the dangers of the country, is certainly as suitable to the character of the English as it is to the character of any other nation.† It is an old English institution; and our Census shows to what extent it can be developed to meet the exigencies of the times.

The militia was almost extinct at the time of the Census. I say nothing of the non-effectives, which amounted to 83,797 in the year 1851, when the effectives were 178,773, making the army and navy 262,570 in the aggregate, of which more than two-thirds were serving. And I omit all the forces in the service of the East India Company; the European part of which would raise the effectives of that year to about 203,807.‡

The following are some of the statistical characteristics of the army and navy. They show how the military differ from other professions. I refer to tables in the Census Report (1851) for the facts.§

(1.) These professions are followed by men only.

(2.) They are followed by men of certain ages; and, although a few are in the returns under 20 and above 40 years of age, the great bulk of the men are of this age, which may be called the athletic age. "It is the age of early manhood. The growth is then completed; weight, stature, and strength are at their maximum." Of 178,773 effectives,

MALE POPULATION of UNITED KINGDOM and ARMY and NAVY at DIFFERENT AGES.

Age.	Male Population of the United Kingdom, 1851, at six different ages.	Army, Navy, and Marines, belonging to the United Kingdom, 1851.
10	1,600,554	879
15	1,494,019	17,351
20	1,268,129	62,364
25	1,084,332	48,282
30	939,525	28,382
35	818,460	13,399

* Book v. ch. i. part 1.
† Jomini, vol. i. p. 222.
‡ Census, 1851, Occupations, &c., vol. i. p. cccli.
§ Ib. vol. i. pp. ccexlv-viii.

including officers, 8,116, or only *one* in 22, were of the age of 40 and upwards; 299 were of the age of 60 and upwards.

(3.) Their numbers fluctuate to an extent unparalleled in other professions. Since the Revolution, the sea and land forces have so fluctuated, as to range from a given number in time of peace to *four* times that number in war, and shortly after the peace back again to the original number.

(4.) *They are unmarried* to an extent of which there is no example—at the corresponding ages—in other professions. At the age 20–25, *twenty* per cent. of the civil population are married. At that age 4 per cent. of the officers of the army, 2 per cent. of the officers of the navy, 5 in 100 soldiers, 6 in 100 seamen, are married.

At the age 30–35, *seventy-one* per cent. of the male population are married; of officers *half* this number, or 35 in the army, 44 in the navy, are married; of the soldiers 28, sailors 47, are married.

Officers in the army marry in larger proportions after the age of 40, but never in the same proportion as men in other professions; after the age of 40 however naval officers excel other professions in this line; from 78 to 84 in 100 of them are living in matrimony at the age 40–60.

Sailors of 45 marry to nearly as great an extent as other professions; the soldiers reach this haven later, so that at 50 and upwards an unusual proportion are married; of the conjugal condition of the ineffectives we have no information.

(5.) The mortality of the army is at the rate of 32 in 1000 in time of peace.* It was, excluding officers, at the rate of 56 in the last French war. The mortality of the civil population at the corresponding ages is at the rate of 9 in 1000. The excess of the mortality in the navy was formerly as great; it is at present much less.

(6.) A considerable part of the excessive mortality is the result of defective sanitary arrangements at home and abroad, and a part is also referable to climate, for it is one of the characteristics of our military force that it is in a state of perpetual movement. In 1851, of the Queen's army, 66,424 were at home, 76,446 were in the colonies, in India, or on the passage out or home.

(7.) The regular forces of a country may consist of foreign troops, or of natives; and, as every great country contains more than one race, the constituent ratios of the several races may differ. England contains men of Irish, Welsh, and Highland blood, as well as Anglo-Saxons and Normans. It is a mistake to talk of us as simple Anglo-Saxons. The English army, like the nation, is a fusion of all these kindred races. The numbers born in England (67,647) are nearly equal to the numbers born in Scotland (15,300) and Ireland (53,169) together (68,469); of the officers, 4,000 were born in England, 836 in Scotland, 1,670 in Ireland. Only 6,754 men of the English army had foreign birthplaces. The royal navy contains few Irishmen; of 35,903 seamen and marines, about 23,401 were of English, 9,466 of Scotch, and 3,036 of Irish birth† Taking these numbers, there were enrolled in the regular forces 91,048 Englishmen,

* Mortality of British Army, p. 10.

† Estimated from the Returns of Seamen, Census, Occupations, &c., vol. i. p. cccli. Proportions: English ·66; Scotch ·26: Irish ·08.

56,205 Irishmen, 24,766 Scotchmen, and this is in the order, but not in the proportion, of the three populations. England, Wales, and the Channel Islands contributed 50 in 10,000 of their population; Scotland 85; Ireland 86; the United Kingdom, which, for the sake of brevity, may be called England, 62 in 10,000 of the population. There is sufficient variety to supply the peculiar qualities suitable to cavalry, infantry, and artillery on land, and seamen on the ocean; while all races, speaking one language, enjoy the same rights, and are indissolubly united by past victories and present liberties. The population of none of the great powers—nay not of France herself—has a firmer solidarity.

Now it follows, as a necessary deduction from what has been said, that the ARMY *and* NAVY *are* NOT SELF-SUSTAINING, and, if they were not constantly recruited from the other professions, the race of British warriors would become extinct. The families of other professions reproduce themselves, and are constantly increasing at home, as well as sending out swarms of emigrants abroad. But it is evident that, if the mortality of the army be undiminished, though the soldiers brought up as many children as the men of other classes—which could only be the case if *four times* as many were married as are married at present—the sons would never equal the fathers in number. Judge then of the state of things under the existing system. Officers cannot often be the sons of officers; soldiers are not the sons of soldiers.

This makes recruiting, which in other professions goes on of itself, a problem of vital interest in the army. It is a difficulty which meets you at the threshold.

If you look into the system of recruiting in other professions, you will see how this difficulty, and another almost equally great, are overcome. The landed gentry do not die out. The troops of artists, clergymen, lawyers, and physicians are easily kept up; the sons always equal the fathers in numbers, and, should the supply fail, the sons of other classes always flow into the ranks. These professions offer honourable and, on the whole, attractive occupation to men. But take other classes: the 159,073 tailors are maintained without any difficulty; the sons replace the fathers. The 282,897 shoemakers are never at fault for successors; the sons replace the fathers. And if there is an extra demand in any of the trades, a rise of wages soon draws into the ranks the required number of the sons of other artizans. The great army of 659,765 farmers, and their men 2,146,936 strong, gets its recruits silently; for the sons replace the fathers.

In this kingdom there are now more than 301,253 miners. The occupation is by no means attractive. It is hard, dirty work, pursued under ground. You see the collier at the coal seams nearly naked, covered with perspiration, in his ordinary employ. The danger in many mines is great. The men are knocked on the head by the fall of coals; they are often burnt; or they are blown up in great numbers. The mortality of miners from violent deaths alone in Staffordshire and in Wales is at the rate of 8 in 1,000 annually:* in Cornwall the mines are so badly ventilated,

* The army at home and abroad lost less than 7 in 1,000 by injuries in action during the wars, 1793—1815. See two excellent papers, by Mr. Hodge, in the Journal of the Statistical Society, vols. xviii. xix.

that the constitution of the men is destroyed in early life. The miners are nevertheless recruited without difficulty. The wages are 3*s.* 4*s.* 5*s.* a-day in Staffordshire, and the men work five days of the week. They marry young in great numbers, and bring up to their business sons whom they send down to the work early in life; you will see how early by this statement:—

	Aged 10—	Aged 15—	Aged 20—	Aged 25 to 30—
Miners . .	35,518 . . .	51,064 . . .	51,302 . . .	40,398

I met in the districts boys who had lost their legs, and been otherwise mutilated in the mines.

Upon asking an excellent man in Staffordshire, who had many boys in his employment, why they were sent down into the pits so early, he replied:—"Unless they go down at an early age, they will not go down at all."

In all disagreeable trades, the wages are raised; the families are multiplied, and the boys are sent to work at an early age by their parents: for boys do not really choose their profession; it is chosen for them. The agricultural and mechanical occupations of the country are all entered before or shortly after the age of 15. So that when you ask for recruits for the army later in life, you ask them to leave some other profession. The country, with its vast dependencies, requires a regular force for its defence. Whether the strength should be 100,000 or 200,000 officers and men, is it not desirable that the class should breed a considerable number of its body? Valour is transmissible. This is an elementary principle in physiology.

> Fortes creantur fortibus et bonis:
> Est in juvencis, est in equis, patrum
> Virtus.

A perpetual class of men is required: by removing the obstacles to marriage, lightening the lot of soldiers' wives, and facilitating the education of their children, you sustain their numbers in the most natural way.

We know what encumbrances—real *impedimenta*—wives and children must be in a moveable force. But human passions cannot be suppressed; soldiers have their affections like other men. And if they have not wives, other women we know surround all camps. Half the sickness probably which disables so large an amount of our forces at home springs from such sources; and it unfortunately happens that the children of the "black-eyed Susans," and of the "girls left behind him" by the soldier, die in wretchedness or live fatherless.

Enforced celibacy in any *large class* necessarily undermines public morals; and ends in the destruction of States. The Romans, after their eastern conquests, expressed a general disinclination to marriage. The Senate in vain passed marriage laws; in vain Augustus reproved and exhorted his officers to marry, and perpetuate the Roman name. The women, descended from the Lucretias of the Republic, became the Messelinas of the Empire; and the legions, having died out, had to be replaced by the descendants of those virtuous Germans celebrated by Tacitus.

Upon all these grounds the restraint of marriage in standing armies appears to be impolitic; it produces disease, it forces corruption, and it cuts off a natural supply of recruits.

Under any circumstances however, a large portion of the recruits must be drawn from the general population. And it is evident, from what has been said, that recruiting is easy in proportion as you take boys at the early ages. There were 1,268,129 men in 1851 of the age of 20 and under 25, of whom 62,364 were in the army and navy. There were 1,494,019 boys of 15 and under 20 in the kingdom; and if the analogy of the mining class were followed, an equal number of them would be enrolled. That is, if you had 62,364 soldiers of the age 20-25; you should have 62,000 soldier-boys. But "boys are unequal to all the duties." Undoubtedly. All our industrial operations are now scientifically subdivided; and thus a part of the processes is performed by the most skilful men, a part is performed by machinery, a part by brute muscular force, and a part is performed most effectively by boys. In Staffordshire, the labour of the young hands is highly valued; at the age of 15 they get 2*s*. a-day, five days in the week.

The dexterity necessary for delicate mechanical operations is acquired early, before the bones are thoroughly set, and the development of the muscles is completed. No one can learn to handle a tool well unless he take it up early. The fiddle cannot be played by people who have not practised from childhood. And do not the arms of the present day require in use a quickness of the eye and a precision of the hand which nothing but early training can impart? You have the great divisions of the army into officers and men, as well as into the different arms; and it is a question for military art to decide whether, by some further subdivisions, profitable employment may not be struck out for boys of 15; although the main work may still be performed by men.

In the merchant service there were 30,987 boys of 15-20, to 39,888 men of 20-25; in Her Majesty's navy, the boys of 10 and under 20 amounted to 5,225, while the men of 25-30 were only 5,567. Probably more able seamen are formed by this arrangement than would be obtained by taking them at 18 into the navy. The majority of our unmatched seamen must have gone to sea as boys, and is it not certain that if the army were entered at the same age the men would attain the same marvellous efficiency?

You have the recruiting of the peace establishment, and you have the recruiting of the forces when the country is at war with France; the wars with other powers being always of comparatively small dimensions. What force can this country raise? We have the analogy of 1811, when the power of England was fully developed; and if we assume that the forces raised should bear the same proportion to the men of the age of 20-40 as they bore in 1811, then the numbers would be 817,229 men.

This was the nature of the force in 1811:

SEA and LAND FORCES of the UNITED KINGDOM.

(See Registrar-General's Sixteenth Annual Report, Appendix, p. 123.)

		Proportion in 1811 to 100 Males living, aged 20—40.	Military and Naval Forces in in 1811.	Military and Naval Forces in 1859, if the Numbers were in the same proportion to the Males aged 20—40 as in 1811.
Sea and Land Forces . . .	(1)	19·5	501,488	817,229
Navy—Seamen and Marines .	(2)	5·3	136,778	222,895
Army—Cavalry, Infantry, and Artillery	(3)	14·2	364,710	594,334
Army and Navy:—				
Native Force	(4)	17·2	441,603	719,640
Foreign and Colonial Force .	(5)	2·3	59,885	97,589
Army:—				
Regular Force, Native and Foreign	(6)	10·7	276,189	450,080
Regular English Force . .	(7)	9·1	233,686	380,816
Royal Troops in India . .	(8)	1·2	30,253	49,300
At home and abroad (exclusive of Forces in India) . .	(9)	7·9	203,433	331,516
Embodied Militia . . .	(10)	3·5	88,521	144,254
Foreign and Colonial Troops .	(11)	1·6	42,503	69,263
„ „ Seamen .	(12)	·7	17,382	28,326

(1) = (2) + (3) (3) = (7) + (10) + (11) (6) = (7) + (11)
(1) = (4) + (5) (4) = (2) + (7) + (10) − (12) (7) = (8) + (9)
(1) = (6) + (2) + (10) (5) = (11) + (12)

It will, I believe, never be wise to embody such a number of men, but *it is in the country*, and, if required, can be produced as easily as the force in 1811, either as a volunteer force, a militia, or a regular force.

§ II.

The power of this country at any given time depends upon the genius of its commanders, the skill of its officers, and the courage and character of its men, more than on the numbers of its population; but, other things being equal, population and power increase together. I will now trace the development of this force. Julius Cæsar first landed in Britain with 12,000 men, and was glad with his fortune to disembark. In his second descent he had 2,000 horse and 5 legions. The Roman

army which conquered Britain was composed of some 50,000 men, and the mutual dissensions of the natives facilitated the conquest. Harold had at Hastings about 60,000 infantry; William fought with the same force, but it consisted of the three arms, and had its due proportion of cavalry and archers—the artillery of that day. After the Conquest, the kingdom was held securely; there was a baron, or military chief, and a strong post in every manor of the country, surrounded by, perhaps, 60,215 knights, in the possession of as many portions of territory. The population of England at that time has been estimated at *two millions*.*

By the Statute of Westminster (13 Ed. I.) every man between the ages of 15 and 60 was to be assessed and sworn to keep armour to the value of his lands and goods. These were the fighting men. Boys of 15 were then accounted fighting men. But this force was only called up for short times, and the feudal service was limited to *forty* days, beyond which the knights could only be retained by their own consent, and at the king's expense. The bow-men, like Robin Hood's men, often owned no fees, and owed no service.

Edward III. in his great wars with France first tried two campaigns with mercenaries in Flanders. His attack failed completely, and he incurred large debts. The population of England and Wales amounted then to about 3,000,000. After the English had destroyed the French fleet, he collected a force of 30,000 men, and landed at the Hogue on July 12th, 1346. Normans, Saxons, and Celts were blended together: for that force consisted of 4,000 men-at-arms (Normans), 10,000 archers (Saxons), 10,000 Welsh infantry, and 6,000 Irish soldiers. With this army the battle of Crecy was fought, and the glorious victory consecrated the fusion of the races. Mr. Hallam remarks:—"Edward III. and his successors, in their long contention with France, resorted to the mode of recruiting by contract with a man of high rank or military estimation, whose influence was greater probably than that of the Crown towards procuring voluntary enlistment. *The pay* of *soldiers*, which we find stipulated in such of these contracts as are extant, *was* EXTREMELY HIGH, *but it secured the service of a brave and vigorous yeomanry*." The population of England further increased, and Henry V. levied an army and landed in Normandy on August 1st, 1417, at the head of 30,000 men, namely, 6,000 men-at-arms, and 24,000 foot, mostly archers. With this force, reduced to about 9,000 by dysentery, the battle of Agincourt was fought on October 25. In the following year he landed in Normandy at the head of 25,000 men, which was reinforced by 15,000, making 40,000 in the aggregate. In 1421 he levied a new army of 24,000 archers and 4,000 horsemen. These armies gave him the daughter and the crown of France.

Machiavelli deduces this lesson from our history.† "There is nothing more certain than that, where men are unapt for war, the fault is in the Government; of which," he says, "we have a fresh and memorable example. There is scarce anybody ignorant, that of late years the King of England invaded France, with no soldiers but his own people; and yet, though England had had no wars for thirty years, and had neither officer

* Census, I. Report, lvii. † Discorsi, i. 21.

nor soldier who had ever seen a battle, he ventured to attack a kingdom full of officers and good soldiers, who had been under arms for several years together in the Italian wars. This proceeded from the prudence of the Prince, and the excellence of the Government, in which, *though in times of peace, the exercise of arms is not intermitted.*"

The army was a militia: yet the victories were not accidents. The order of battle—the same at Crecy and Agincourt—was, it is said, an improvement on the formation of Hannibal at Cannæ: the conduct of the kings in command and of the troops was excellent; and the archers had had bows in their hands from boyhood. They did not begin to use their weapons for the first time at the age of twenty.

The "fighting men" were enumerated in Elizabeth's reign, and amounted in 1583 to 1,172,000, which would imply that the population was about 4,445,400. All the seamen in England amounted to 14,000; the land forces amounted to 79,000, at the time of the Armada.

Up to the reign of her successor, Scotland was frequently at war with England. Next to France, she was the most constant adversary. The King of England—

> Never went with his forces into France,
> But that the Scot on his unfurnished kingdom
> Came pouring, like the tide into a breach.*

The crowns were united in James; and the population of England, about 5,466,000 in 1651, became 6,378,000 by conjunction with Scotland; but in this year of Cromwell's "crowning mercy," that country was garrisoned by his troops. The union was in fact first completed by the genius of Chatham, who placed arms in the hands of the Highlanders.

Blake, in the command of thirty ships, entered the Mediterranean Sea, where no English fleet, "except during the Crusades, had ever before sailed." And the army "never failed to destroy and break to pieces whatever force was opposed to it."† Under Turenne, the English troops beat the famous Spanish infantry, and took Dunkirk. The army which proved invincible was not large; but it had a peculiar character. "*The pay of the private soldier was much above the wages earned by the great body of the people;* and if," says Macaulay, "he distinguished himself by intelligence and courage, he might hope to attain high commands. *The ranks were accordingly composed of persons superior in station and education to the multitude.* These persons, sober, moral, diligent, and accustomed to reflect, had been induced to take up arms, not by the pressure of want, not by the love of novelty and licence, *not by the arts of recruiting officers*, but by religious and political zeal, mingled with the desire of distinction and promotion."

The army and navy assumed unusual dimensions during the reign of William III.; 40,000 seamen and 87,702 men under the head of land forces, were voted in 1694; and as supplies, £2,382,712 were voted for the navy, £2,500,000 for the land forces. While the seamen remained at 40,000, the land forces voted during Marlborough's campaigns were, on

* Shakespeare, Henry V. Pope Martin V. said: "In truth the Scots are the only antidote of the English."—P. Hist. of Eng. ix. A.D. 1421.

† Hume; Macaulay.

an average, 50,000, and never exceeded 65,210. The British force at Blenheim did not apparently exceed 9,000; and throughout the war, their "valour and order" appear to have been more striking than their numbers. "The troops," Marlborough writes in 1708, "are in so good a condition that it would gratify your Highness to see them."*

The power of England increased slowly, and after the peace of Aix-la-Chapelle, in 1751, the population was about 7,392,000. In that year Clive marched from Madras at the head of 200 Europeans and 300 sepoys to Arcot, and the English became subsequently masters in India. The seven-years war followed, in which Prussia, allied with England, fought France, Austria, and Russia; and Spain also engaged in war against England. 70,000 seamen, including 19,061 marines, and a land force of 77,046, in all 147,046 men, were voted; the supplies for that year (1761,) were £3,912,226 for the navy, and £1,793,033 for thea rmy. The naval force of England was chiefly engaged; but Wolfe's victory led to the cession of Canada by France, and of Florida by Spain, at the peace of Paris in 1763. The after-loss of the American Colonies—the cession of Florida and Minorca to Spain, of Senegal and the French East Indies, were the result of the great war with the United States, France, Spain, Holland; and of the armed neutrality. The population at that time could scarcely sustain the position England had attained. The new manufacturing arts, and the mines, created a demand for skilled labour; wages rose, and the army low pay drew only an inferior class of men into its ranks. Their inferiority in the use of projectiles, which had been the glory of English troops, was evident in the American war, and in the early wars of the French Revolution, where ignominious failures were not wholly the fault either of incapable generals, or defective sanitary measures.

That the people of Ireland were alienated from England by commercial jealousy and bigoted intolerance, we are reminded by such events as the battle of Fontenoy, the Irish volunteers, and the Rebellion of 1798. The Union did something to heal the breach in 1801, and the good work has since been completed. The population of the *United Kingdom* amounted at the Union to about 15,957,000, and it grew during the ten years of war to 18,221,000 in 1811.

To recapitulate: when Edward III. invaded France, he had about 3,600,000 subjects, English and Irish. When Queen Elizabeth encountered the Spanish Armada, she was at the head of 5,000,000. When Cromwell asserted the power of England in Europe, and Blake's flag swept over the Mediterranean, of the 7,470,000 people in these islands, 2,000,000 at least in Scotland and Ireland were hostile to the Government. George III. in the war which the great Chatham directed, drew his forces from 9,742,000; and now Queen Victoria reigns over 28,000,000 people, of whom 4,238,000 are of the military age; or if you go back to the age of 15, and take the old definition, 8,000,000 are fighting men. On the standard of 1811 she can cover the seas and maintain in the field for many years a force of *eight hundred thousand men*. I leave out of account the force of the Colonies and India.

The population of the other great powers of the world has also rapidly increased: Russia has conquered all the parts of the Northern hemi-

* Despatches, vol. ii. p. 243, June 11, 1708.

sphere except the valiant states of Sweden, Norway, and Denmark. The great powers of Prussia and the United States of America have increased more rapidly than England. The population of France was to that of England as 27,000,000 to 16,000,000 in 1801; it is now as 36,000,000 to 28,000,000. These numbers are nearly as 17 to 10, and 13 to 10 respectively. France, notwithstanding the great outlet for population in Algeria, has seen little increase of her children recently; and in 1851 the number of English children under five years was greater than the number of French children. Frenchmen of the age 20–25 are now nearly 1,523,000, and Englishmen of that age are 1,508,000. The numbers at the conscription age are nearly equal. So much for the power of England estimated in men.

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§ III.

I have now to notice some points in war finance, which can be illustrated by statistics.

Adam Smith lays it down that "*the whole army and navy are unproductive labourers.* Their service," he says, "how honourable, how useful, or how necessary soever, *produces nothing* for which an equal quantity of service can afterwards be procured."

What have we to say in reply? Shall we enumerate the glorious victories which illustrate English history? Unfortunately political economists see few charms in military glory. They count the cost, and remind us of the destruction of property and life in war.

Shall we enumerate the British possessions which have been acquired by the vigour of successive Governments and the valour of the army and navy? British North America, the West India Islands, the fortresses in the Mediterranean, the islands in the Atlantic, the points on the west coast of Africa, South Africa, the small islands in the Pacific, New Zealand, Australia and its gold mines, Hong Kong, India—making 7,895,000 square miles of territory, some of it fertile in the highest degree. That is something solid. But *colonies do not pay*, exclaim the economists. They will not pay even for their own defence. The American colonists began a great war with France, and *rebelled, because they were called upon to pay a fraction of the costs.*

Upon looking at the matter more closely, it can however be demonstrated, upon the principles of political economy, that a defensive force is productive in the true sense of the word. Take the navy. The seas are now covered with British merchandise. In the trade-returns, the value of the exports is set down at £126,000,000; the value of the imports at £192,000,000.* Ships are insured, and the other day the mere rumour of war raised the rates of insurance. Insurances, Chalmers says, were never, except in peace, made on such reasonable terms as in the last war—"*after the capture of the enemy's corsairs and the ruin of his fleet.*" Insurances, I suspect, would run up now very rapidly, if England had no fleet. Perhaps some of the powers which have fleets might find out satisfactory reasons for sequestering our merchantmen: and if all nations suppressed their fleets, the

* £4,508,000 transhipped appearing in both.

seas would be covered with swarms of pirates. The insurances to cover losses would then exceed the expenses of an adequate navy preventing losses, if trade were carried on; but trade would be, in such a state of things, impossible.

It is not an easy matter to estimate the value of property in the United Kingdom; but if we capitalise the value of the labour, and include the property, it cannot amount in the aggregate to less than £10,000,000,000; and the value of the annual produce probably exceeds £400,000,000. The possession of that property is secured against foreign aggression by the army and navy. The property is now insured for £48,000,000 a-year, including the charge on the war debts, that is, at a premium of *five farthings* on the pound, or a little more than 12 per cent. on the produce.

The British dominions abroad, exclusive of India, are *fifty-five* times as great in extent as these islands. What the value of the property is to the colonists, I do not pretend to determine; but if the protection of the British flag were withdrawn, colonial property would be in imminent jeopardy; and it owes its security to the army and navy. England protects her colonies, almost as a father protects his children at her own expense. Some of them are approaching, and will, we may hope, soon attain, their majority. They will be able to defend themselves, with some assistance in extraordinary emergencies.

Labour is required to create property; and property loses all its value if it is destroyed. The labourers require protection in carrying on their work; and the owners must be secured in their possessions. This service is absolutely required; it is therefore obtained, and paid for like other labour, which is of no more than equivalent value. Any expenditure on an army exceeding the sum required to secure the life, property, and freedom of the people, is, I admit, entirely unproductive; and this view deserves the attention of the continental monarchies.

It is then evident that as much military force as is required to defend a country is productive; and the value of the product is expressed economically by *the rate of insurance indispensable to maintain the security it affords*. Our forces may be legitimately employed for other purposes than defence against attacks. They may be, in my opinion, employed in the support of any righteous cause which can only be promoted by arms. But England, as Hume acutely remarks, is ever too ready to engage in war, particularly against her great rival; and this is turned to account by continental diplomatists.

In the six wars since the Revolution (1688) England, besides the sums annually raised, contracted £802,000,000 of debt. The amount of the debt is now £803,000,000; the annual charge, £27,412,000. The wars with France last, on an average, 11 years; and the three wars from 1793 to 1815—which were really one—extended over 22 years. Such are the resources of these two great states. The amount of debt contracted in every war increased: in the four last wars the debt contracted was 31, 64, 121, and 529 millions. It was doubled twice, and then quadrupled. I am afraid to announce the next term of this progression. And I hope it is unnecessary; as, if the country engage in a just European war, let us hope that our statesmen will appeal to the patriotism of the people for a large portion of the supplies within the year;

and adopt measures to prevent the waste which was exhibited in raising and expending the public money in former wars. Then England, adopting a wise economy, will meet with no difficulty in procuring the "guineas" which Jomini holds are so great an element of her strength. For she paid for the supplies of her army, not only in Spain, but in France itself; and has yet met every one of her engagements since the Revolution, while the other great powers have several times been bankrupt. France repudiated a great part of her debts five times in that period, and once under Sully. "Thus," says Bresson, one of the latest financial writers, "the public faith has been broken six times in two centuries; each generation has seen a national bankruptcy."* Punctuality in meeting her engagements is the explanation of the credit of England, which some continental writers, strangely enough, regard as a "secret."

War has led heretofore to the greatest waste of the national resources, not, be it remarked, to the profit, but to the loss of the army and navy; and in the last European war immense sums were thrown away. There was no proper audit; and only a very imperfect publication of the accounts, both of men and money. In the present day the financial accounts go a great deal into detail; but, as statistical documents, they are exceedingly imperfect. The items require judicious classification. The number of officers and men voted appears in the estimate, but where is there any account of the men actually serving? The items of income and expenditure appear, but there is an immense durable stock of ships, timber, wares, clothing, forage, barracks, and warlike stores, which never enter into the annual accounts; when this stock is consumed the annual expenditure is apparently low, and we have what the simple call "a model year;" when it is augmented, as in the present day, the expenditure is made to appear higher than it really is. To present a true account, *stock should be taken at the beginning of every year;* and the public accounts would then become reliable statistical documents.

If we divide the total expenditure on the army, navy, and ordnance, in the year 1811 by the mean strength, it is found to be at the rate of £112 a man in the currency of that year, or £97 in gold. The cost in 1851 was nearly at the same rate, £99 per man. Owing to the operations on the stock, the value of which does not figure in the public accounts, the expenditure, £21,143,000, divided by 176,906, the number of men, gives the higher rate of £118 per man for the financial year 1859-60. The expenses of warlike stores, and of their manufacturing establishments, should be distributed equitably between the army and navy; but in what proportions I cannot learn. I divide the expenditure under these heads into two equal parts for the moment; and the figures stand thus, after excluding the troops on the India establishment:—

	Officers and Men.	Expenditure by Estimate.
Army	117,906	£10,678,000
Navy	62,000	£10,465,000

The annual expenditure in the army, including every item, is £91 per man; in the navy, £169. This includes the pay of ineffectives, who are maintained for the sake of the effectives.

* Histoire Financière, par J. Bresson, tome ii. pp. 439–41

A correct statistical account would show the amount and value of every kind of store, and the expenditure per man in the several regiments and ships. The Government could thus exercise an effectual check on the expenditure.

The wages and victuals of officers and men in the navy amount to £56 per man, or one-third part of the aggregate expenditure. To secure their services they are promised half-pay and pensions, which they will one day enjoy; this item of expenditure makes £19 a-head. The ships and establishments cost £64 per head; and this year £16 extra for building and conversion; the warlike stores and their artificers £14 a-year, if half the ordnance charge belongs to the navy.

I wish to direct your attention to two points in *army* finance. The expenditure is at the rate of £91 a man, or, exclusive of the pensions and half-pay, is £72 per man. The pay and money allowances are £32 a man; provisions, fuel, light, clothing, necessaries, £9 a man; barracks £7 a man; equal to £48 a man. This includes officers.

If we separate the officers, their pay on an average is £233 for each officer, exclusive of half-pay and retiring allowances. The pay, allowances, clothing, medical attendance, necessaries, and barracks of the non-commissioned officers and soldiers, amount on an average to £29 8*s*. a-year; add £5 as the equivalent in present pay of the contingent pension, and the soldier's pay is £34 8*s*. a year, or 13*s*. 3*d*. a week. Whether the soldier be inefficient from sickness or natural incapacity, whether he be weak or strong, dull or quick, stupid or intelligent, all the items of expenditure, except pay, must be the same; and in war the losses by the failures and defects of sick, feeble, incapable, unintelligent armies are costly, and may be irretrievable ruin to their country.

The first economy which statistics have shown is practicable in the British army is *economy of life:* the mortality is much higher than the mortality of the civil population at the corresponding ages, not only abroad but at home. The causes are known, and they can often be removed. It is the same with sickness. Of the British army in the Peninsula 9,300 out of 44,500 (21 per cent.) were constantly sick. The mortality in the army of the East was at the rate of 26 per cent. of which 20 per cent. was by disease; the sickness was in the same high proportion. The sickness and the mortality were formerly as high in the navy; they have been reduced at sea, and they can be reduced by land. The statistical labours of Mr. Marshall, Mr. Edmonds, Mr. Hodge, Sir Alexander Tulloch, and Dr. Balfour, and the inquiries which have been conducted by Commissions and Committees, over which Mr. Sidney Herbert has presided with indefatigable zeal, and with remarkable ability, show how the army might be made a comparatively healthy profession for good men in the prime of life.

Great economy in the end will be realised in the army by the introduction of good arms. And our military history shows that still greater advantage will arise from inducing good men to handle those arms; the legitimate inducements being, in this as in all other professions, good treatment and adequate pay. What is adequate pay? I make one or two observations on this matter, because the pay of the army—unlike that of the navy—cannot be regulated by the competition of a convertible pro-

fession analogous to the merchant-seamen. I have several returns of wages; but it will be sufficient to mention that, while the class of labourers earn 18*d.* a-day, or 2*s.*, a large class of miners and artizans gets 4*s.* a-day; carpenters and masons get now 5*s.* a-day at Greenwich Hospital; some of our highest classes of artizans earn 7*s.* and 10*s.* a-day. This is of course exclusive of Sunday. Their work is not always constant, and they get no pensions. Apprenticeships are served in many of these trades; which, as I have shown, are all entered early. Now the pay and treatment which will draw the sons of men of these classes into the army can only be determined by experience. But it appears to me that you will, for the future, have to pitch the pay of officers and men on a higher than the present scale, to compete successfully for the best men in the field; that you must take many boys at ages as low as fifteen; that you must have different classes of men, at different rates of pay; and that you must abolish all such interference with the men as the forbidding to marry, which is, in the eyes of every man, a grievance, and is probably actually injurious in various ways. The army will thus be a profession, honourable down to the lowest ranks; and a prudent father may recommend his son to enlist in the service of his country. You have abandoned the press in the navy; you repudiate conscription; cast to the winds the inveiglements of the recruiting serjeant, which are unsuitable to this age.

Real economy will be consulted by employing the best men in the population, and limiting their numbers. As in the middle ages men covered themselves with armour till they could not fight, so there is a constant tendency now in nations to call out great armies, which they cannot move or maintain in health. It is a species of cowardice. Let us not imitate their example. Queen Victoria, like Alexander, can find soldiers wherever she can find men; and there are eight millions of them in these islands; but it is quite certain that if a large part of the population become as familiar with the rifle as their ancestors were with the bow, an army and navy of 800,000 men—the equivalent proportion of the force under arms in 1811—*will never be required in any future war.* Half the number of skilled men will do the work.

The descendants of the small armies of men that won victories under Edward III., Henry V., Cromwell, Marlborough, and Wellington, will always sustain the honour and interests of their country. Give her volunteers, create a militia by all means; but this country out of its present population can organize such a regular army as will never fail "to destroy and break to pieces whatever force is opposed to it." The flag which Blake hoisted in the Mediterranean will still float over its waters; and if England cannot preserve the peace of the world, her sword will bring down the scale on which it is thrown by the Queen. The colonies will be defended; these shores will remain inviolate.

MALE POPULATION of SEVEN GREAT STATES, distinguishing the Numbers living at Five Ages.

(See Registrar General's Sixteenth Annual Report, Appendix, p. 123.)

Years for which the Population in the Table is given.	STATES.	MALES.					
		Total.	0—20.	Military Age, 20—40.	40—60.	60—80.	80 and upwards.
1851	England - - - -	13,687,545	6,417,101	4,111,481	2,245,358	842,624	70,981
1851	France - - - -	17,794,964	6,562,179	5,541,462	4,020,275	1,566,864	104,184
1844	Turkey - - - -	17,533,124	9,361,323	4,784,490	2,448,275	857,013	82,023
1840	Austria - - - -	18,202,631	8,465,132	5,242,611	3,271,212	1,152,356	71,320
1849	Prussia - - - -	8,162,805	3,821,608	2,535,891	1,342,320	462,986	
1855	Russia - - - -	33,448,093	17,858,678	9,127,414	4,670,594	1,634,931	156,476
1850	United States of America (exclusive of the coloured population)	10,026,402	5,114,831	3,160,028	1,339,838	376,427	35,278
	TOTAL - -	118,855,564	57,600,852	34,503,377	19,337,872	7,413,463	

Evening Meeting.

Monday, February 21st, 1859.

Colonel the Hon. J. LINDSAY, in the Chair.

The Chairman announced that Sixteen Members had joined the Institution since 31st January.

LIFE MEMBERS.

Jones, R. O., Lieut. Roy. Eng.
Clinton, H. R., Ens. 71st. Highland L. I.
Young, W. L. M., Commissary Field Train Department.

ANNUAL SUBSCRIBERS.

Kaye, Horace, Ens. 5th West York Mil.
Bussell, W. G. H., Lieut. 23rd R. W. Fus.
Lowe, R. N. C. D.; Bt.-Major Gr. Gds.
Flower, Lamorock, Lt. 3rd R. Surrey Mil.
Beamish, H. H., Comr. R.N.
Moore, G. W., Maj.-Gen. Bombay Army.
Harrington, R. E. S., Lieut. Rifle Brigade
Browne, Henry J., Lieut. 19th Regiment
Mountcharles, Earl of, Capt. 1st Life Gds.
Gilbard, Geo. Jno., Cornet 16th Lancers
Alexander, Jas., Major.-Gen. H.M.I. Forces
Wilson, S. W. F., Capt. 55th Regt.
Napier, Gerard Jno., Capt. R.N.

NAMES OF MEMBERS who have paid increased SUBSCRIPTIONS since 31st January.

Flower, Lamerock, Lieut. 3rd R. Surrey Mil.
Gamlen, C. A. Lieut. h.p. 3rd Pro. Batt.

DONATIONS.

	£	s.		£	s.
Edwards, H. R., Admiral . .	1	0	Clinton, H. R., Ens. 71st Highland Lt. I.	3	0
Pollock, Sir Geo., Gen. G.C.B.	2	0			

PRESENTS.

LIBRARY.

Books.

Sampson Sandys, Esq. Hints on National Defence. Pam. Lon. 1859. *Presented by the Author.*

Catalogue of the Lepidopterous Insects in the Museum of the E. I. Company. Vol. I. Papiliones, Sphinges. 8vo. London, 1857. *Presented by Secretary of State for India.*

The Platoon Exercise for the Rifle Musket: translated into Turkish for the use of the Turkish Contingent, by W. H. J. Lance, Esq., Lieut. 98th Regt., late Capt. Turkish Contingent, Instructor of Musketry 98th Regt. 8vo. *Presented by Capt. Perrott.*

Major G. T. Haly, Madras Army. The Reorganization of the Native Army, Police, &c. of India. Pamp. large 8vo. London, 1858.

Suggestions for the Dress, Camp Management, &c. Pamp. large 8vo. Lon. 1858. *Presented by the Author.*

No. V. Journal of the National Shipwreck Institution, of the 1st July, 1852.
Presented by Walter Hawkins, Esq.

The Crimea, by Col. Jervis; Geological Edition, by W. P. Jervis.
Presented by Col. W. F. Hamilton, C.B., Gr. Gds. in the name of the Sevastopol Model Committee.

Sir Macdonald Stephenson. Railways in Turkey; Remarks upon the practicability and advantage of Railway Communication in European and Asiatic Turkey; with Maps. 8vo. London, 1859. Map of Turkey to accompany the above. *Presented by the Author.*

The Tente d'Abri. By M. Lecompt, Chef. d'Escadron. Translated from the French, with additional Plates and Remarks, by Lieut.-Col. Hallewell. Pam. Malta, 1859. 2 Copies. *Presented by Lieut.-Col. Hallewell.*

Report of the Ordnance Survey, together with Minutes of Evidence and Appendix. London, 1858.

Papers, Ordnance Survey, 30th June, 1857.

Medical and Surgical History of the British Army during the War against Russia in the years 1854-5-6. 2 volumes. London, 1858.

Royal Warrant, 24th October, 1858, and Report of the Committee appointed to inquire into the existing organization of the Commissariat Department, with Evidence and Appendix. 1 vol. *Presented by Col. P. F. D. C. Stuart, Gren. Gds. M.P.*

Royal Society, Proceedings of. Vol. IX. No. 33. *Presented by the Society.*

The Royal Agricultural Society of England, Journal of. Vol. XIX. Part II. No. 42. *Presented by the Society.*

Maps—Plans.

Chart of the Curves of Equal Magnetic Variation, 1858.
Presented by F. I. Evans, Esq., R.N., F.R.A.S.

Plan of part of the Parish of St. Oswald, in the County of Durham; scale, 25·344 inches to a mile. Specimen by Zincography, transferred and printed at the United Service Institution, 4th February, 1859, in illustration of a Lecture delivered by the donor. Three Copies.
Presented by Col. H. James, R.E., F.R.S., Superintendent Ordnance Survey.

Topographische en Militaire Kaart van het Koningrijk der Nederlanden vervaardigd door de Officieren van den Generalen Stafen Gegraveerd op het Topographisch Bureau van het Ministerie Van Oorlog, op de Schaal van 1:50:000. Folio, 21 Plates. Voorschrift ter Vervaardiging van Kaarten. 8vo. *Presented by the Netherlands Government.*

MUSEUM.

Military.

Three Elongated Rifle Bullets. *Presented by Capt. J. Norton.*

A Chinese Bamboo Jacket, worn as defensive armour, taken off the body of a Chinese Soldier at Chingnan-foo, during the Expedition of 1842.
Presented by Major Haley, H.M. Madras Army.

Miscellaneous.

A Gold Medal, presented to Sir William Hillary, Bart. by the Members of the Royal National Institution for the Preservation of Life from Shipwreck. This medal was awarded to Sir William Hillary as the original Projector of that Institution. It is worthy of favourable notice as an early and very beautiful performance of that admirable artist, the late Mr. Wyon. *Presented by Walter Hawkins, Esq.*

Russian Admiralty Flag, found at the foot of the Sheers, in the dockyard, Sevastopol, the morning after the place was taken.

Basket for red hot Shot, taken at the batteries at Kinburn.
Presented by Capt. George St. Vincent King, R.N. C.B.

The Chair was afterwards taken by CAPT. FISHBOURNE, R.N.

TAYLERSON'S DIAGONAL PRINCIPLE OF IRON SHIP BUILDING.

By R. Taylerson, Esq.

Having been honoured with the charge of bringing before this Institution my patented diagonal principle of building iron ships and of giving such explanation in elucidation of it as I am able to afford, I beg to assure you of my full appreciation of the honour conferred on me, and of my grateful sense of the opportunity thus presented to me of bringing into public life the object of my most anxious and ardent aspirations under the auspices of this distinguished Society.

I fear, therefore, that I shall have to claim a large measure of indulgence at your hands whilst I proceed to lay before you, as clearly as I can, the diagonal principle, the true mechanical basis upon which it rests, and the practical proofs of its superiority over the present vertical mode of building iron ships.

Before we enter on the discussion of the main topic of my address, viz., my diagonal plan of building iron ships, I shall, with your permission, take leave to advert to some preliminary or introductory topics which seem to me to be inseparable from a comprehensive consideration of the subject of iron ship building.

In whatever way we look at this subject we cannot but be forcibly struck with the two great features, or elements, which stand prominently forward in connection with it, and demand our most serious attention: the first is the raw material, and the second is the capital to be brought to bear upon the development of it. That England is favoured beyond all other countries in the enjoyment of the former, is a conceded fact; and, that she commands in an eminent degree the golden sinews necessary to bring the raw material into active vitality, can admit of equally little doubt. Yet, after all, and the history of the world attests the fact, it matters not to what extent we may flatter ourselves as the favoured possessors of those substantial elements of wealth with which our country abounds; without the aid of their handmaid, Science, we can never hope to maintain unrivalled the art of iron ship building, or continue to be the principal recipients of the riches to be derived from this source.

It is true, and we can easily comprehend the fact, that should this country, slumbering in false security in the proud possession of these elements, lapse into a lethargic state of industrial mental culture or scientific training, the raw material and capital might for awhile enable her to hold the vantage ground she proudly occupies; but, should this mental apathy continue, and should a transition take place by which those local advantages would come to something like a level with other countries, in consequence of our capital and raw material finding their way there on easy terms, when superior skill and science were applied to fashion them into floating arks, we should discover our mistake when it was perhaps too late, and we should be painfully reminded of the scathing, sarcastic reply of the

great mathematician Euclid to his pupil Ptolemy-Lagus of Egypt, who, when asked by that indolent prince "if there were no shorter way to learn geometry than by studying his Elements," said, "No, sire, there is no royal road to geometry." Neither is there a royal road to wealth through the unaided instrumentality of those substantial elements, if we will not take the trouble to cultivate the art and science essential to the proper development and shaping of them to the end in view, namely, that of constructing such ships, and such alone, as will give confidence and security to life and property in their perilous ventures on the vasty deep.

Nor is this mere idle theory, for the proof is at hand to sustain it faithfully. From one instance we can learn all. Let us take the fact of America importing our steel from our own Sheffield, and exporting it to us again in the manufactured state in the shape of the adze, the axe, and the spade, at a cost, temper, and finish, cheaper and better than we can produce them. It is plain that this is the result of a superiority on the other side of the Atlantic, in an advanced state of the art of manufacturing the metal. Let us hope that iron ship building will never be an item in this category of national inferiority.

We are now come to the consideration of my diagonal principle of construction as contradistinguished from the present vertical mode of constructing iron ships, which is directly opposed to scientific principles.

On looking at an iron ship of the ordinary construction standing in frame, (Plate I.) it will appear that the frames without the plates offer no resistance to any force tending to tear the ship asunder in the direction of its vertical planes. The frames are placed vertically, and parallel to each other; and, instead of giving strength to the structure, they absolutely require the attachment of the outside plates to keep them in their places. These frames are secured to the outside skin by rivets, in a direct vertical line from the gunwale to the keel on each side of the ship, thus presenting a series of lines of weakness, owing to the displacement of iron to make the rivet holes necessary for attaching the outside plates, just as is familiarly illustrated in the perforations in a sheet of postage stamps.

This weakness, it is manifest, springs from two causes: First, the frames being in a vertical direction and parallel to each other cannot offer sufficient resistance to any force or strain having a tendency to tear the ship asunder transversely. Secondly, the frames being secured, as I have stated, to the outside shell by rivets running in a direct vertical line from the gunwale to the keel, they entail one continuous line of weakness in that direction.

Being thoroughly satisfied that there was a radical defect and an inherent weakness in this mode of construction, and reading of many accidents, resulting in a deplorable loss of life and property, attributable to, and occasioned by, this weakness alone,—the ships, to use the uniform language of these painful narrations, "breaking their backs," or in other words breaking in two parts, from the gunwale to the keel,—I conceived the idea of the diagonal principle, which I shall now proceed to lay before you.

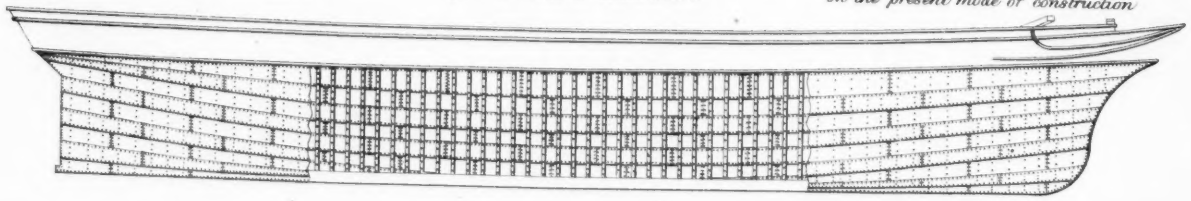
My proposition, in relation to my diagonal method, is this, namely, that, in the case of the vertical principle just now detailed, the line of resistance to any force acting in the direction of the vertical planes of the ship will be in a line with the shortest circumferential line of the body of the ship,

TAYLERSON'S PATENTED DIAGONAL PRINCIPLE OF IRON SHIP BUILDING

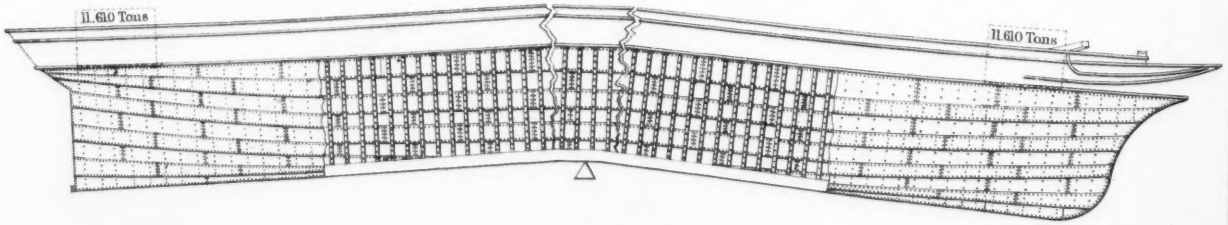
Nº 2
Shewing the plating of an Iron Ship on the present mode of construction

Nº 1
Shewing an Iron Ship in frame on the present mode of construction

Nº 3.
Shewing the plating of an Iron Ship on the present mode of construction



Shewing an Iron Ship on the Vertical Principal, breaking her back by the Strain upon her.



J.R.Jobbins.

thereby opposing the least amount of resistance to fracture coming in the direction of these planes; whereas, in the case of a ship built in accordance with my diagonal principle, the line of resistance to forces acting in the direction of these vertical planes will be diagonal to the circumferential line of the body of the ship, thereby opposing the greatest amount of resistance that can be given at an angle equivalent to the inclination of the frames.

The same argument and the same reasoning apply to the perforations in the plates, or outside skin, which, running in the same vertical line with the frames, as already described, produce a series of lines of inherent weakness in the structure of the ship, and which I propose to remedy by my patented mode of making the line of junction of the butts of the plates diagonal, instead of vertical, as in the present mode of construction.

So much, then, for the superiority of the diagonal principle as applied by me, so far as theory establishes the position, over the vertical method now in use; but I should ill discharge my duty to you, Mr. Chairman and Gentlemen, and to myself, if I came here with a theory of my own, unarmed with that practical proof, which no doubt you will expect from me. I am prepared with proofs, derived from actual experiment, that warrant my asserting that in point of strength ships built on the diagonal system are stronger than those on the vertical, at the rate of 100 per cent.

To this I shall revert more in detail, and give the experiments, when I come to lay before you the structural details of a ship now building by me at Port Glasgow, when I trust you will pardon the emphasis I have used in speaking of the diagonal principle, for I am not without hope that I shall be able to convince you that no iron ship has yet been launched with similar claims to structural strength as the one to which I shall have the pleasure of calling your attention.

The next branch of my patent, to which I would beg to call your attention, is my hollow girder keel and keelson.

You are no doubt aware that at present iron ships are built upon a solid rectangular bar of iron. Now, it would appear pretty evident that the keel, mechanically speaking, should answer the double purpose of a base on which the frames are to rest, and from which the outside plates spring, and also a foundation of strength to the whole structure; and the question naturally arises for our inquiry, is this solid rectangular bar the best and the strongest that we can supply to meet the requirements of this double purpose? Now, it appears to me that it is not, and that the hollow girder keel and keelson combined will give an increase in point of stability of about 40 per cent. beyond that of the rectangular bar, and this is long since established as an accomplished fact. It is well known that the solid rectangular bar of iron has very little power of bearing a load or resisting a tranverse strain, and that if it were placed on its edge on props at the extreme ends it could hardly sustain its own weight, but that laid flat, and kept in its place by side attachments, as in the hollow girder keel and keelson combined, which I propose in its stead, its strength would be augmented, owing to its increased area, to resist transverse strain not less than from 30 to 40 per cent.; and this is the principle so beautifully exemplified in that magnificent model structure—the tubular bridge which spans the Menai Straits.

I now beg to introduce to your notice another part of my mode of building iron ships, in connection with my diagonal frames, of more than ordinary moment, which, with the public, has done more to establish confidence in the safety of iron ships than any other quality which they possess, I mean watertight bulkheads; but, although bulkheads under the present mode of construction are said to be watertight, they are not so in reality, because were the angle iron frames from which they spring so closely riveted as would be necessary under the pressure of a column of water, say 18 feet (the load immersion of most of our large steamers), the frame to which the bulkhead is secured would be nearly cut in two by the displacement of iron to form the rivet holes, whilst by the mode adopted by me the rivets may be put from 6 to 9 inches apart, and yet make a complete watertight compartment in the ship.

I am now going to give you the structural details of the ship now building by me at my works at Port Glasgow. I shall beg your particular attention to two cardinal points or features of structural stability not to be found in any other ship that has yet been built.

The frames or ribs of this ship, which constitute the main support of the ship, run in an oblique direction from the starboard gunwale down the side and across the keel, to which they are firmly united by an intercostal keelson and four sister keelsons, these continuing their obliquity up the opposite side to the larboard gunwale. The poop and forecastle beams are secured to one frame on the starboard side, and to a different frame on the port side. The main deck beams are also fixed to different frames, and also the lower deck beam; that is, the end of the main deck beam is secured to one frame on the starboard side running forward, and to a perfectly different frame on the port side running aft, which frames, being placed diagonally reverse to each other, are 28 feet apart at the gunwale, but joined together at the keel, by which means almost every beam is fastened to a frame, and the floors are likewise fastened to the frames, so that the ship forms a complete network of iron, embracing diagonal and vertical combinations of structural stability amounting to double that of the present mode of building iron ships. Before this ship can break in two parts or tear her plating asunder, she must break through 20 frames of angle iron $4\frac{1}{2}$ by 3 by $\frac{1}{2}$ inches, as well as 10 frames of angle iron 3 by 3 by $\frac{7}{16}$; whereas in a ship built on the vertical principle the poop and main and lower deck beams are secured to one frame only on the starboard and port sides, and they are three feet apart at least, which leaves every alternate frame unsustained by any beam at all, so that on the application of any force to produce a rupture in a vertical line there is not a single frame interposing to resist the rupture from the keel to the gunwale. The outside plates are $\frac{11}{16}$ and $\frac{3}{4}$-inch thick in all parts when so required by Lloyds'. She is divided vertically by four watertight bulkheads half an inch in thickness, and these are strengthened by diagonal stays or bars; and, having a deck of iron besides one of timber, she is, so to speak, a hollow tubular girder similar to the Britannia Bridge, with this exception, of course, that the bridge is a flat structure, whilst the bottom of this ship is an inverted arch, which is acknowledged to be a necessary form for the bottom of a ship.

Let us now turn our attention to the experiment, made with the most

TAYLERSON'S PATENTED DIAGONAL PRINCIPLE OF IRON SHIP BUILDING.

Nº 5.
Shewing the side of the Ship plated on Taylersons principle

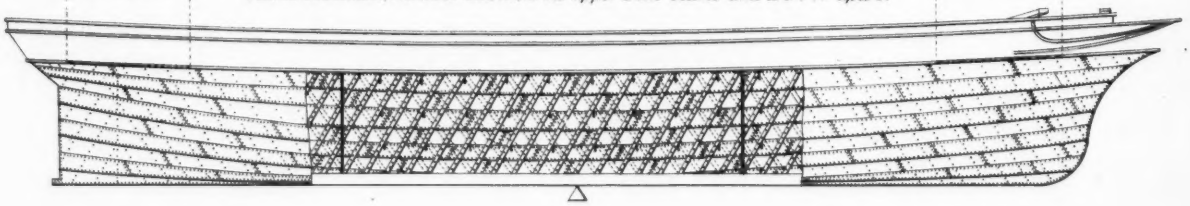
Nº 4.
Shewing the side of a Ship in frame on Taylerson's patented diagonal principle the frames carried fore & aft.

Nº 6.
Shewing the side of the Ship plated on Taylerson's principle

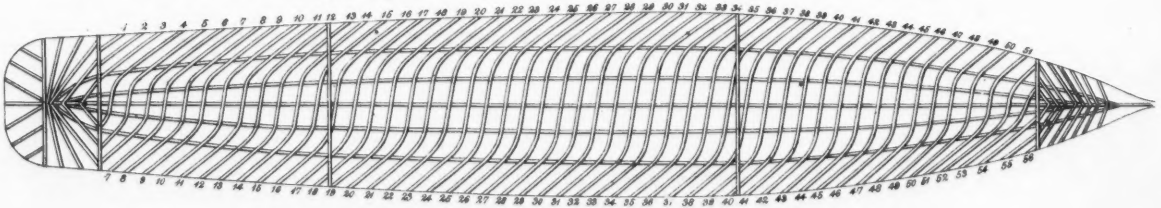
23.152 ½ Tons

Dotted Lines show the Starboard side
Black Lines show the Port side
a are Poop, between Deck and Hold Beams
b Hold Stanchions, from the keelson, to the upper Deck beams and are 7 ft. apart.

23.152 ½ Tons



Nº 7.
Shewing the frames inside of a Ship built on Taylerson's patented diagonal principle



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scrupulous fidelity, to test the strength of this diagonal principle so adopted by me.

Two models were constructed for this purpose, one to represent the present vertical mode of building, and the other to represent my patented diagonal principle. In all other respects the models were precisely similar, each having an elastic keel to admit of a proper distribution of the strain, which in this experiment was obtained by placing weights on the ends, whilst each structure rested on a fulcrum intended to indicate the position of a rock or sand-bank under its keel. The result of this experiment proved that, whilst a ship built according to the ordinary plan would be torn asunder vertically through her plating, or, as the phrase is, "break her back," and break in two, a ship built on my patented diagonal principle would resist a strain from *more than double the amount of force without any injurious effect whatever;* and, in the experiment referred to, the model representation of the principle was not even twisted by the great amount of strain upon it. *(See Mr. Thornton's Report appended, page 235.)*

It is truly appalling to read the long, sad list of casualties at sea. The similarity of narration, and almost identity of language, in which these and many other disasters are recounted, clearly show that they all originated in the same cause—the inherent weakness of which I have spoken, and the want of an adequate power of resistance to any force or strain coming in the direction already indicated; in fact, resulting from the utter radical and inherent weakness in the structure of those vessels.

In glancing for a moment at some of those melancholy accidents recorded in the public journals of the day, I trust I shall not in their relation give offence to the feelings of any gentleman who hears me, for nothing can be further from my thoughts. It is the principle not the man I blame. Ships must be built upon the present system, such as it is, until a better mode is supplied, and it is perfectly plain, from this very similarity of narration and identity of language, that the fault lies not at the door of the shipbuilder, but with the system itself. In narrating the loss of the ship "Eva," The Times says, "that she was struck by a heavy sea, whereby all on board were alarmed by a loud report, which on investigation was found to have been caused by the breaking of the keel right in the centre, the vessel having broken her back." The Times also, in narrating the fate of the "Birkenhead," says, "She went on shore and broke in two halves—400 of the passengers perished." The Liverpool Albion, speaking of the then new screw ship "Yorkshireman," says, "She went on shore and broke in two." The Shipping Gazette, in speaking of the loss of the "Duchess of Sutherland," says, "that on entering the port of Aberdeen she broke in two halves." The "Tayleur" shared the same fate, when 450 souls perished in the wreck;" and in the memorable instance of the "Prince," at Balaklava, The Times states, "that she struck on a sunken rock, filled with water, drifted, grounded, and in less than twenty minutes she broke in two parts, and all on board were immersed in the deep." The loss of the "Transit," in the Southern Ocean, occurred in a similar way, her plating having split in one part, and 600 tons of water having been pumped out of her within twenty-four hours. Many similar cases might be adduced, such as the "Nemesis," the "Ida," the "Loire," the "Pacific," the "City of

Glasgow," the "Ada," the "Brigand," &c. for, unhappily, they abound in the records of our naval disasters.

There never was a period, perhaps, in the annals of naval architecture, when the subject of shipbuilding occupied, and properly, so large a share of public attention; but, whilst we cannot but admire the talent and practical science which have been brought to bear upon the subject, we are amazed to discover a total omission of a cardinal element in the construction of iron ships, and that is, I say it emphatically, *sufficient strength.*

This state of affairs in relation to iron ship building cannot but create some uneasiness in our minds, when we are assured that with the public it is no longer a question which of the two to choose, "the iron or the wooden ship," for to the former they have given a decided preference, on account of lightness, capacity for cargo, speed, durability, and economy in repairing and in cost; this is an array of excellent qualities which must for ever command and maintain, in an eminent degree, a supremacy in the commercial world for the iron over the wooden ship.

In a great country like England, rich in the possession of the raw material, in the capital and skilled labour to bring it into active developement, with a never-failing demand to reward the shipbuilder for his enterprise and skill, he must be dead to every feeling of national pride, and to the most powerful of motives that can sway the human breast, self-interest, if he does not respond, by an untiring zeal and perseverance in the cultivation of art and science. I have already said we must not rely on our local advantages, the mere possession of the raw material, for depend upon it, if in our advance we neglect to further the union of science with industrial art, we must be contented to forfeit with becoming resignation the high prestige we have so proudly maintained, and the uninterrupted prosperity we have hitherto exclusively enjoyed.

A MEMBER.—Did I understand the Lecturer correctly to say that all the ships whose disasters have been described were iron ships?

MR. TAYLERSON.—All of them; and there have been a great many other similar cases—I could name fifty or more.

MR. SMITH (*Editor of the "Artisan"*).—I should like to ask Mr. Taylerson the comparative cost of his system as compared with the very best system of iron construction, either on the Clyde or on the Thames.

MR. TAYLERSON.—There are some who would build for a great deal less than I could; but I should say that, taking any of the first builders, I would undertake to build the same class of ship on the same specification at from 5 to 7½ per cent. extra. There is no doubt that I should use a little more iron. I quite admit that, inasmuch as the frames are longer than in the case of a vertical-built ship, and also that in the plating of the ship the corners have to be taken off the iron. I pay for my iron £1 a ton more—but that is only on the plating.

MR. SMITH.—Do I rightly understand that there is the same carrying capacity for the same displacement?

MR. TAYLERSON.—Yes—for the same displacement.

MR. SMITH.—Because those are material points. If, with an increased

quantity of material, and the same length and breadth, you would have, as a matter of course, greater immersion.

MR. TAYLERSON.—Yes.

MR. SMITH.—And if also, as I take it, your method of construction involves the occupying of a greater internal space, there is no doubt you would have less carrying capacity for the same extreme measurement.

MR. TAYLERSON.—There would be so very small a difference that it would be scarcely worth naming. I would also observe, that, if this system was properly carried out, you might build a stronger ship with a less quantity of iron; for this reason—Lloyd's agents, who have been superintending this ship building, have frequently said, "Take away three of your frames, and yet you would have a stronger ship than one built in the other way." Only last week a gentleman who had been examining my ship for a house in Liverpool told me that if the ship had had two out of every three of her frames less she would have been stronger than a vertical ship. He made that observation himself.

MR. SMITH.—I think Mr. Taylerson has brought before the Meeting an exceedingly ingenious and meritorious system of construction of iron ships. The matter is deserving the best attention of naval architects and those who are interested in the employment of iron ships. I think, however, that the statement of Mr. Taylerson with respect to what he assumes as the defects of the present system of iron construction should not pass without some observation from me. I do not agree with him that, because the ribs of an iron ship of the ordinary construction spring from the keel at right angles thereto, and form a curve of the smallest circumference, that therefore the ship is of a very weak form. I am quite prepared to admit that too little regard is paid to the construction of the keel and of that which should form the vertebræ of the structure; and I also admit that, in a great many instances in the trade of iron ship building, as in every other trade, there is a want of scientific attention to the details of construction; but in all well-designed iron ships, I think Mr. Taylerson will find that what he scientifically sets about doing, and doing in a very nice way, is, or should be, attained from the system adopted of breaking the joints of the plates. I think it is unfair to say that, because the ribs are vertical, at right angles with the keel, therefore the plating is of the weakest possible structure. On the contrary, as the plates in their length have their joints broken, as in the ordinary bonded brickwork, supposing the proper dimension of rivet and rivet hole to have been selected in proportion to the thickness of the plate, the rivet holes should not be the weakest part of the plate. If it were so, I need not say that the Britannia Tubular Bridge would be an exceedingly weak structure. But, as in the case of the Britannia Tubular Bridge and every other hollow girder, whether it be on that large scale or smaller, the strength of the structure depends upon that plating—for, take the plating away, and you have a bundle of square rings, parallellogram shape, which being framed together by longitudinal bars, and plated externally, form the girder; and it is upon the external plating that the strength of the tubular-girder bridge depends. It should be the same in every well-constructed iron ship. I quite admit that from the want of attention, as I before observed, defects do creep into the construction of iron ships, especially

where they are built by contract at very low prices, very often at prices that are unremunerative to the builders; and there lies the great secret of the defect of the most elegantly-shaped ships.

Passing from that subject, I come back to the point of the principle proposed by Mr. Taylerson. He has brought before you an exceedingly interesting subject, though I think he will have more difficulty in carrying out his plan to the high state of perfection which has been attained by the present system of iron ship building than he at present sees. I hope I may be wrong—I wish him every success; but whenever you commence a structure where the lines are constantly varying, and such a structure as an iron ship, where you require well-defined lines, if there is any truth in Mr. Scott Russell's wave-line theory, we ought to be able to determine at every three inches, or every one inch, the exact curves taken at every part of the ship, and to be able to set them out by templates. Mr. Taylerson would have some difficulty in laying down his lines upon the floor, considering that these ingenious and beautiful angle ribs are constantly varying. It becomes an exceedingly difficult thing to lay out a ship with the varieties of curves such as you can obtain by the present system of iron ship building. That is only a matter of opinion; however, it is one which I think, nevertheless, deserves some attention by Mr. Taylerson. Upon the question of weight, to which I alluded in asking Mr. Taylerson the question I did as to the expense, if you place your ribs at the same distance apart, it is pretty clear you would have a greater weight for the same dimensions, and, I think, 5 per cent. is a very small increase of cost for the increased strength which Mr. Taylerson gets by his improvement. I do not exactly understand the arrangement as to the watertight bulk-heads. If it is to give greater resistance to the column of water, which unfortunately is not provided for in all vessels, that part of the vessel being in some vessels which I have seen quite disproportioned to the other parts, and if Mr. Taylerson carries out the improvements he has represented as pertaining to his keel, and which I certainly believe do belong to that system of building, he will have effected a very great desideratum in the construction of iron ships.

CHAIRMAN.—Will you explain how you get over the difficulty alluded to by Mr. Smith as to the moulding?

MR. TAYLERSON.—Iron, when hot, readily takes any form. We had a little trouble at first in laying down this first ship, but as we went on we found very little more trouble than in the common mode. When we first began there was a little difficulty, but afterwards, when we got into play, we got the frames just as well moulded as the common ones. I think you spoke of ships not breaking up?

MR. SMITH.—No; unfortunately that is too true. I think it is more from the defect of the keel itself than from the structure.

CHAIRMAN.—Notwithstanding Mr. Smith's objections, I go entirely with Mr. Taylerson. I think the condition of the present mode of iron ship building is pretty much what that of the wooden ships was before the introduction of Sir Robert Seppings' trusses; and the only difference between iron ships as now constructed and wooden ships before that time is, that in the wooden ships the planks were put edge to edge, there being no means of attaching them to each other except the bolting through

the timbers, while in the iron ship you overlap the plates of iron and rivet through them, which gives great strength in the direction of the ribs. But there is an important point which deserves to be remarked on, which makes it all the more necessary that iron ships should be stronger in the direction of the length, and that is, the want of elasticity in iron. Thus a heavy sea acting upon a ship's quarter lifts her; as a necessary consequence there is a bending action set up, to which the weakest part, generally that near the middle, yields, and the iron, not having elasticity, remains in a bent position; then another and another sea comes, and causes further bending, till it establishes a crack. That was the case with the "Nemesis."

It is also frequently the case that parts of ships are borne down or not supported by an amount of buoyancy equal to the weight in these parts, from which there is a constant stretch upon the centre part of the ship, and a tendency to break. In ships on the old plan, the strain falls between the timbers, therefore no strength in that direction is afforded by them, whereas in Mr. Taylerson's system, the breaking force must cross a series of timbers, say 18 or 20, before the ship can break. That I think is a marked distinction, and an exceedingly valuable one. Another point with respect to iron ships is this, that, although the sleepers upon which the engines are placed run a considerable distance along the ship, affording proportionate strength, and although there have been many plans to obviate the remaining weakness, by girders, making the sleepers in the form of girders, so making an inverted arch on which the engine is placed, still weakness exists beyond the parts reached by them. This Mr. Taylerson's method entirely obviates. Indeed Mr. Smith admits that it is a very ingenious and important principle if the weight is not materially added to. In a man-of-war it is of course a very important thing to give excessive strength to the ship—and in plate-sided ships one of the greatest difficulties is to have a frame-work of sufficient strength to bear the iron plating. By Mr. Taylerson's plan a great deal of strength is added to the water-tight bulk-heads, because the strain is divided over a number of timbers instead of being confined to one or two. When it is estimated that £80,000,000 worth of property is constantly afloat belonging to this country, and which is gradually finding its way into iron vessels, the importance of the subject becomes manifest. I have much pleasure, Mr. Taylerson, in conveying the sense of obligation under which this meeting feels to you, and I trust your invention will obtain that approbation from the public to which it is entitled.

Mr. Thornton's Report.

Having had much practical experience in the manufacture and testing of iron, and the strength of structures built of that material, I have every confidence in stating that the diagonal principle, as developed in the ship now in course of construction by Messrs. Robert Taylerson & Co., at Port Glasgow, exhibits vast superiority in strength over the vertical principle upon which iron ships are usually built.

Suppose a ship to rest upon a fulcrum in the centre of its keel, and equal weights to be placed at each extremity with a tendency to tear the ship asunder vertically amidships, as shown in the accompanying plate, then—

To tear asunder a ship built on the vertical principle, size and weight of metal being the same as Taylerson's, a strain would be required equal to 11,610 tons weight at each end, whereas—

A ship on Taylerson's diagonal principle would bear a strain equal to a weight of 23,152½ tons without any injurious effect upon the vessel. See plates 1 and 2.

These calculations are based on the strength of iron structures as ascertained by experiments in the construction of the Menai Bridge and other works of great magnitude, and the arrangement and distribution of material in ships built upon the vertical and diagonal principles respectively; and they clearly demonstrate that no ship built on the vertical or longitudinal principle can bear anything like the same amount of pressure or strain as that which might be borne without injury by one constructed on Taylerson's patented diagonal principle.

(Signed) ROBERT THORNTON, C. & P.E.

St. Leonard's Iron Works, Edinburgh,
15th November, 1858.

Evening Meeting.

Monday, March 21st, 1859.

Captain E. G. FISHBOURNE, R.N., in the Chair.

The Chairman announced that fourteen Members had joined the Institution since 7th March.

ANNUAL SUBSCRIBERS.

Waller, Geo. H., Capt. 7th Fusileers
Grey, F. D., Major 63rd Regt.
Davis, Sir Jno. F. Bart. K.C.B., Deputy-Lt. Gloucestershire
Hancock, H. J. B., Ens. 45th Regiment
Shipley, W. D., Capt. 58th Regt.
Brown, Henry, Col. H.M. Indian Forces
De Blaquiere, Lord, late Lieut. 41st Regt.
Farquhar, A., Capt. Aberdeenshire Highrs.
Heywood, Wm., Capt. 14th Regt.
Brabazon, L. B., Capt. Roy. Art.
Long, C. P., Capt. 13th Light Infantry
Fletcher, T. H., Lieut. Mil. Train
Bent, Hugh, Capt. Roy. Art.
Spicer, Henry, Capt. late 4th R.S.Midx.Mil.

NAMES of MEMBERS who have paid increased SUBSCRIPTIONS since 7th March.

Stevenson, Wm., Surg. ret. Beng. Army
Watson, D. H., Lieut. R.N.
Reddie, James, Esq.
Young, Wm., Commissary-Gen.
Armstrong, J. W., Lieut.-Col. Prov. Batt.
Wesley, S. R., Maj.-Gen. R. Marine Lt. I.
Hancock, H. J. B., Ens. 45th Regt.
Brown, Henry, Col. H. M. Indian Forces
De Blaquiere, Lord, Lieut. late 41st Regt.
Aitchison, General
Brabazon, L., Capt. Roy. Art.
Dinnen, Jno., Esq., R.N.
Spicer, Henry, Capt. late 4th R.S. Mid.Mil.
Briggs, John, Gen. Madras Army
Leake, M., Major-Gen.
St. George, Jas., Lieut. Col. R.A.
Davis, Sir Jno. F. Bart. K.C.B., Deputy-Lt. Gloucestershire
Burgoyne, Sir Jno., Gen. G.C.B.
Adair, R. A. S., Col. Suffolk Mil. Art.
Shipley, W. D., Capt. 58th Regt.
Cleather, E. I., Col. late R. S. Corps
Wells, J. S., Master R.N.
Baillie, D. J., Capt. R. H. G.
Long, C. P. Capt. 13th Lt. Infantry
Bent, H., Capt. Roy. Art.

DONATIONS.

	£	s.		£	s.
Narrien, Jno., Esq., F.R.S. . .	0	10	Pakington, Sir John S., Bart. .	5	0
Aitchison, Gen.	2	0			

PRESENTS.

LIBRARY.

Books.

Royal Artillery Institution. Occasional papers of. *Presented by the Institution.*

Catalogue of the Admiralty Library. 1 Vol. 8vo. London, 1858. *Presented by Lords Commissioners of the Admiralty.*

45 Volumes of Works, comprising the course of Instruction at the Royal Military Academy, Breda. *Presented by the Netherlands Government.*

A History of British Ferns, by Edwd. Newman.

Principles of Scientific Botany, by Dr. J. M. Schleiden.

Manual of British Coleoptera or Beetles, by J. F. Stephens, F.L.S.

Manual of Botany, by J. H. Balfour, M.D. F.L.S. &c.

Le Bon Jardinier Almanach pour 1846. 2 Vols.

Flore Française, par Messrs. de Lamarck et Decandolle, 5 tomes.

Vocabolario Piemontese-Italiano e Italiano-Piemontese, del Sacerdote Michele Ponza. *Presented by Capt. H. L. de la Chaumette.*

The Campaign in India, 1857-58, from drawings made during the eventful period of the Mutiny, by George Francklin Atkinson, Capt. Bengal Engrs., illustrating the Military Operations before Delhi and its neighbourhood, with descriptive letterpress. Folio, London. Jan. 1st, 1859. *Presented by Colonel T. Taylor.*

Royal Geographical Society. Proceedings of. Vol. III. No. 2.

Maps—Plans.

Map of the Gwalior District, in 4 sheets. *Presented by Secretary of State for War.*

MUSEUM.

Military.

Two Liquid-fire Rifle-shells, adapted to a deep-grooved Enfield Rifle.
Presented by Capt. J. Norton.

"TENTS," from their EARLIEST PERIOD to the PRESENT TIME; showing the NECESSITY for providing WATERPROOF and WELL-VENTILATED TENTS for the covering of Troops in the Field; and the evil results when inefficient shelter is provided: considered in a sanitary and pecuniary point of view.

By GODFREY RHODES (MAJOR UNATTACHED).

THE subject of "tent-architecture" is one of very early origin; and, although the necessity of supplying efficient shelter for troops in the field is at the present time fully acknowledged, yet little or nothing has been done towards accomplishing that requirement.

It is a fact that enormous sums of money and great encouragement are awarded for the perfection of destructive missiles; yet little or no support, and but scanty supplies are granted, towards (what ought to be the first step) supplying efficient shelter for the preservation of the health of our own troops when encamped in the field.

The earliest mention we have of tents is in the 4th chapter of Genesis and the 20th verse, where we are told that "Jabal was the father of such as dwell in tents and of such as have cattle;"* evidently meaning that he was the inventor of tents, and of pitching those moveable habitations required for a nomadic life.

We find after the Flood, that Noah,† Lot,‡ Abraham, and the two sons of Isaac (Esau and Jacob §), lived in tents; and, although it is natural to suppose that, as "Esau was a cunning hunter and a man of the field," he required those portable dwellings, yet we find (Genesis, chap. 25) that "Jacob was a plain man dwelling in tents," giving us sufficient evidence that tents were the earliest constructed habitations of man.

It is impossible to ascertain with precision what was the peculiar form and construction of the Patriarchal tents; but, as the Arabs deviate so little from the customs of their forefathers, we shall not be far from the truth if we consider the present Arab tent the nearest existing approximation to the ancient model.

To illustrate the subject I will briefly describe the present Arab family tent.

Their most usual sized tent is from 25 to 30 feet long, by about 10 to 12 feet in breadth; it has nine poles. To pitch the tent, the three

* About 4000 years B.C.
† About 3156 years B.C.
‡ B.C. 2080.
§ B.C. 1915 years.

longest poles (viz., from 7 to 10 feet in length) are placed in the middle, at equal distances apart, and three of the others (about 5 or 6 feet long) are placed in like manner on each side; to the top of these, the black goat's-hair cloth (with which the Arabs cover their tents,) is secured; and owing to the skill of the women, who manufacture all the tent coverings, even the heaviest rains do not penetrate this closely woven fabric. The side coverings, or walls, are often of a coarse woollen cloth. The tent-coverings are kept stretched out in the usual manner, viz., by cords, which latter are fastened at one end to the top of the poles, and at the other, to pegs driven into the ground, at the distance of three or four paces from the tent.

The front of the tent is usually kept open, except during the winter, and the back and side hangings are so managed, that the air can be admitted in any direction, or excluded at pleasure.

The weight of a tent of the above dimensions is about 1500 lbs., or the load of two strong camels.* I may mention that tents of much larger, and even smaller, dimensions are used, according to the rank and wealth of the owner.

It is not my intention to enter here into the minute details of the tents and coverings as used by the Israelites during their wanderings in the Wilderness, as such would take up too much time, and perhaps afford but little interest to many of my hearers; but, as there is a diversity of opinion with reference to the various translations of the Hebrew words "Or thakhash," which have been generally rendered badger-skin, (such being supposed to have been used as the outer covering of "The Tabernacle,") I may mention that there is no certainty that the outer covering of "the Tabernacle" must necessarily have been made of badger-skins: on the contrary, the commentators, as Jarchi, &c., raise the question, whether any part of an unclean beast (and such is a badger) should or could have been used for the outer covering of that Sacred building.

The celebrated and generally correct historian Josephus, in his description of the offerings made by the Israelites when encamped at the foot of Mount Sinai, only states "that the upper curtain was of a stuff that was proof against rain;" again, "that the outer covering was of skins, for a shelter against heats and rains, and for a fence against the injuries of the seasons." Niebuhr says, that there is a fish in the Red Sea which the English call porpoise or sea-hog, and which is called by the Arabian merchants "dāhash:" the skin is used for bucklers, and is said to be musket-proof. Other authors say the skins are used for covering huts, &c. It is well known that badgers do not now inhabit (if they ever did) the neighbourhood of Mount Sinai; and, as the porpoise is still to be found in the Red Sea under the name of dāhash, it may fairly be assumed that the "thakhash" of the Hebrew is the "dāhash" or porpoise of the present day. The circumstance of the want of water in the wilderness, and the close approximation of the Red Sea to the Sacred Mount, may be of sufficient circumstantial evidence, that the Holy Tabernacle was covered on the outside with the skin of the porpoise, and not with that of the badger. There is nothing very remarkable in the employment of fish-skins as an

* Camels can carry from about 400 to 700 lbs., and elephants, from 1000 to 1500 lbs. each.

outer covering for tents, for at the present day the "Fishing or Alien Tuski" (a nomadic people who inhabit the extreme northern and eastern point of Asia, bordering on Behring's Straits,) cover their tents with the prepared skin of the walrus, which is so beautifully cured as to retain its elasticity, and, owing to its semi-lucent properties, sufficient light is admitted by the roof to render windows quite unnecessary. Lieutenant Hooper, of the Royal Navy, who, when belonging to H.M. ship "The Plover," wintered amongst that tribe in 1848, states that he saw a walrus-skin of the enormous size of 70 to 80 square feet, and that the whole was as transparent as parchment. I may here mention, that the Alien Tuski can raise the temperature of their tent to 90 and 100 degrees of Fahrenheit: they obtain this great heat by burning lamps filled with train-oil, using the fibres of "weet-weet" or moss as a wick. Lieutenant Hooper says that "there is neither smoke nor smell when these lamps are well trimmed." There is another tribe called the Tungoozes, who cover their tents with fish-skins; these Fishing-Tungoozes inhabit the south-eastern Siberian coasts, from the banks of the river Aldan (63° N. latitude, and 130° E. longitude), and a large river called by the Tungoozes, Okat, signifying, in a somewhat exclusive sense, "The River," which, flowing in a S.S.E. direction from the town of Yudomsk, and passing by Arki, emerges into the Okhotsk Sea, at the seaport town of Okhotsk (55° N. latitude, and 143° E. longitude).

With respect to the general form and mode of constructing the tents of the numerous nomadic tribes which inhabit the earth, it is sufficient to say, that their form is generally conical, sometimes with a centre-pole, but more often formed of straight poles having their upper extremities converging to one centre, and so arranged, that a fire can be lighted within the tent, permitting the smoke to escape through an aperture at the top. The various coverings, or textures, which are used for tents, consist in camel's-hair cloths, rude felt, and goat-skin tissues; reindeer and buffalo skins; the birch-bark, chuco-leaf thatch, palm-mats, reeds, and sword-grass, and the membranous and silky leaves of the vijao-plant; also a species of cloth made from the fibres of a root called lift-adum; the sail-cloth of the modern Laplanders; and the sheltering ice-blocks of the Esquimaux; to say nothing of the brilliantly-coloured cloths, embroidered velvets, and gold-starred satins which have decked the tents of kings, chiefs, and conquerors in Europe and Asia, from the period of the middle ages down to the insignificant and shelterless canvas tents of the present day.

I will not enter into the details of the Tentology of the ancient Jews and Scythians, the Babylonians and the Egyptians, the Greeks and the Romans, neither the Kurds, the Tatars and Calmucs, the Turks and Esquimaux, Australs and Patagonians, nor the more modern systems of the great European States, such as France, Austria, Prussia, Russia, Sweden, Hanover, and Belgium, but will at once proceed to illustrate the British army-tents of the present day. I will endeavour to explain their peculiarities of construction in detail, point out their general defects, call your attention to some very valuable remarks already recorded by professional men, having the object of directing public attention to the necessity of providing efficient coverings for our own troops when encamped in the field, and finally, will bring to your notice a proposed remedy, in

the shape of a new system for constructing curvilinear and other tents, of my own invention.

The object I have in view is to endeavour to apply a practical remedy for an acknowledged and still existing deficiency.

The tents at present adopted in the British army consist of three, viz. :—

First. "The Hospital marquee."

Secondly. "The field-officer's marquee."

Thirdly. "The circular single-poled tent."

The hempen canvas of the hospital tent is supported by two or three vertical poles, of nearly 14 feet each in length, secured together, at their top ends, by a ridge-pole of 13 feet 10 inches long.

When the canvas has been stretched out, and secured to the ground by 184 pegs, (which number includes the 4 large pins to secure the storm ropes) the canvas walls (5 feet 4 inches in height) are hooked on to the bottom edge of the sloping canvas roof, and then pegged to the ground at that part which touches it. The roof and walls of this tent are of double hempen canvas, having a space between each, of about one foot. The inside ground measurement of this tent is 29 feet long, by 14½ feet wide, and as it is understood to afford accommodation for not less than 18 or more than 24 men, it would in the latter case permit of 2 feet 5 inches, by 6 feet 6 inches for each soldier, allowing 18 inches for a passage down the centre of the tent.

This tent, when pitched, covers a space of ground 20 paces by 17, or about 340 square yards.

The weight of these tents, when dry, varies from 428 to 507 lbs., and when wet, from 644 to 676 lbs. Or, in other words, the weight increases about one-third, viz., in the former, the increase is 216 lbs. against 169 lbs. of the latter. (These tents are of different sizes.)

It is thus evident, that if the canvas was effectually rendered waterproof, greater efficiency, and a large saving of transport would be the result. (See the table of sizes and weights of tents in the "Aide Mémoire to the Military Sciences," published in 1845-6.)*

A tent of the above dimensions contains 3,310 cubic feet of air, which would allow of about 275 cubic feet each to 12 men, about 183 cubic feet each to 18 men, and about 137 cubic feet each for 24 men. The hospital marquees are not provided with suitable means of ventilation.

The Field-Officer's Marquee.

This tent is, in shape and arrangement of its details, only an "Hospital marquee" on a reduced scale.

When pitched, it occupies about 126 square yards of ground, or 9 paces by 14; its weight when dry is about 173 lbs., and when wet 244 lbs., being an increase of 71 lbs. (See table of tents in the "Aide Mémoire to the Military Sciences," 1855-6.)*

N.B. This marquee is not much used.

* This useful work has omitted to describe military tents, only giving their respective weights.

The Circular Single-poled Camp Tent.

This tent, with some slight modifications, has been in general use in the British army for about 60 years (if not rather longer). Formerly, the canvas was supported by one centre pole, and without the short vertical wall with which the present conical tents are supplied; its height was 9 feet, its width about 12 feet, and it was capable of holding 12 men.

A complete tent so constructed only weighed 43 lbs.

The following are the dimensions, &c., of the "circular conical single-poled tent" at present in use. (I may premise, by stating, that the British army tents vary in size, and consequently in weight.)

The diameter of this tent is 12 feet 6 inches; height, (or length of pole,) 10 feet 4 inches; accommodation for 12 to 14 men; weight of the linen tent (complete) when dry, is from 68 to 75 lbs., and when wet, about 104 lbs. The height of the vertical circular wall is 12 inches, and its object is to give increased head-room to the soldiers when lying down.

The number of pins required for this tent is 43, viz. 40 for the tension ropes and loops, and 3 for the long storm ropes. This tent is provided with one triangular entrance, and is deficient* of a proper means of ventilation. The above sized tent contains about 512* cubic feet of capacity, allowing to each soldier about 64 cubic feet, 8 men per tent; about 51 cubic feet, 10 men per tent; about 42 cubic feet, 12 men per tent; and about 34 cubic feet, 15 men per tent.

General Defects of the British Army Tents.

Their general defects consist—

1st.—The canvas of which they are made is not always of the best material.

2nd.—The canvas and tent-ropes are not waterproofed; and, owing to their absorption of moisture, the weight of the tent is increased nearly one-third, and by their contraction, when wet, materially assist in pulling the wooden pegs out of the ground, thereby rendering the tent less secure during stormy weather. The alternate saturation, and drying of the canvas and ropes, must materially tend to rot them.

3rd.—Want of an improved method in the construction of the present army tents, from the apparent inability of applying to them an efficacious and simple plan of thorough ventilation, &c., which, from the latter being very defective, together with over-crowding men into a confined space, is, but too often, the chief cause of those zymotic diseases—viz. "fevers," "diarrhœa," "dysentery," and "cholera," which are the greatest enemies to troops employed in active warfare.*

Young lads of 18 to 20 years of age, are much more liable to contract zymotic diseases, than men of 22 years and upwards; the former are generally deficient in physical strength, whereas the stamina of the latter, being more fully developed, their constitutions are better able to bear the harassing fatigues incidental to armies in the field.

* *Vide* Report of Sanitary Commission, 1855—56.

To illustrate the point in question, I may, perhaps, be permitted to briefly mention "that during the campaign of 1809, some troops which were cantoned in the north of Germany marched to Vienna, and, although the distance was only short, all the hospitals on the line of march were filled with sick: more than one-half of these men were under 20 years of age."—Again, "during the year 1805, a French army, which was cantoned in the neighbourhood of Boulogne, marched about 400 leagues to join the grand army in Moravia, prior to the battle of Austerlitz (fought 2nd December); but owing to the more matured physical strength of these men, (all above 22 years of age and 2 years' service,) this long march was accomplished without leaving almost any sick in the hospitals on the line of route."

With respect to No. 1 Defect, I find that the two Commissioners (Sir John McNeill and Colonel Tulloch) reported, in 1855–56, that "some of the tents were of an inferior quality, and that in many instances the army was obliged to use the single-poled camp-tent for hospitals, instead of the marquee, although the latter was far more appropriate for such a purpose."

No. 2 *Defect.*—I have already called your attention to the increased weight of the army tents when wet; and, with respect to their general deficient waterproof qualities, I can state, from personal experience, that in the autumn of 1848, I was encamped for about two months, with a detachment of my regiment (then 2nd Batt. 60th Rifles), at Kilkenny; and, although the weather was not unusually wet for Ireland, still a misty dew penetrated the canvas, and rendered everything within the tent uncomfortably damp.—During the winter of 1854, when I was in the Crimea, the general complaint of the British army tents was, that they were neither waterproof nor ventilated, and I can well remember the wet and puddled state of the windward half-ground portion of the interior of many of the tents, caused from the incessant beating of the rain and wind against the canvas, which latter was ill adapted to resist the combined action of the rain and wind, for a continuous period of sometimes ten days: on the contrary, the "Turkish Circular Conical Tent" was dry, warm, and waterproof, owing to its covering being of double cotton canvas; besides, from its great width, and comparative lowness, it withstood the fearful hurricane of the 14th of November, when nearly all the British and French tents were blown down. With reference to the deterioration of the tents from the effects of the variation in the weather, I find, on reference to page 123 of the printed "Report of the Sanitary Commission," (despatched to the seat of war in the East, in 1855–56,) that in the month of May, 1855, the Commissioners "recommended the striking and removal of some tents to a fresh surface, owing to the damp state of the ground inside the tents." The Commissioners were informed, that "the supply of tents was deficient, and that it was impossible to strike the tents pointed out, as they were too much decayed to admit of removal."

No. 3. *Defect.*—With respect to the very important subject of defective ventilation, &c. of the present army tents, I beg to bring to your notice the recorded opinions of several professional men.

The late Dr. Robert Jackson, "Inspector-General of Army Hospitals," states, that "There is great room for improvement in the manner ordina-

rily employed for covering troops from the inclemency of the weather during a campaign." He recommends the use of "a carpet of painted canvas to be laid on the ground inside the tent, and, by preventing the ascent of moisture, generated by the raised temperature within the tent, from its occupation (more particularly by the immediate or near contact of the heated bodies of the men with the surface of the earth), would greatly tend to lessen those evils (arising from the contaminations of the air) to which soldiers are subject, when crowded together in close or unventilated tents."

The doctor recommends "a tent with a light roof," but acknowledges "that the application of it is connected with trouble." He further states, that "a roof, similar to that of a marquee, is liable to be overturned by strong winds, and a tent with close walls is liable to be contaminated."

I must again refer to that valuable "Report of the Sanitary Commission" in respect to the general want of ventilation of our army tents. They state "That the most obvious sanitary defect in the tents was their want of ventilation." "It is usual on a march for 12 to 15 men to sleep under a bell tent. The cubic space for each soldier is 51 to 64 cubic feet, but the consequent evils from overcrowding tents would be greatly mitigated by ventilation. The indispensable necessity of renewing the interior atmosphere of the tent is indeed fully recognised, for there are a few small openings for this purpose, near the apex of the tent, but they are of too small a size to be of use."

"*Ventilation.*"

Again, "We had occasion to examine the ventilation during the outbreak of cholera in May 1855, and were struck on entering the tents by the foulness of the atmosphere. This led to inquiry, and we found the men were perfectly aware of this defect, and complained of it themselves, especially in the mornings."

"At the same date we found instances of sick, being treated under bell-tents,* and in going into one of these, we saw pans of peat charcoal on the floor, and were told by the surgeon, that were it not for the use of charcoal for absorbing the emanations from the sick, the air of the tent would have been unbearable—a very sufficient proof of the great necessity for a better ventilation."

The Commissioners again state, "that to remove as far as practicable the evils of overcrowding tents, it appears indispensably necessary to improve their ventilation." With respect to the sanitary condition of the "Hospital-Marquees," the Commissioners state that "the usual method of ventilation in 'marquees,' is by opening or raising the side walls; but this method can hardly be said to be sufficient, even in favourable weather, and still less is it, when from rain or high wind the sides cannot be opened. Even in the fine weather, it was remarked that the air under the roof of the marquee was hot and stagnant (although the sides were open), because there was no provision for its escape above."

The Commissioners state that "*the whole question of ventilation, as regards field hospitals, is one of very great importance;*" and with respect

* It is to be remarked, that the "bell-tents" here referred to are the "single-poled conical soldiers' tents."

to the rapid recovery of the sick and wounded, they state, that "well-ventilated field hospitals answer much better than would be fulfilled by a much larger amount of ill-ventilated cubic space." Consequently, "to well ventilate a field hospital is, in other words, to save transport." They pointedly remark, that "a permanent and independent means of ventilation is particularly required at night, when the doors and side hangings are closed."

In their concluding remarks they state, "that the atmospheric impurities arising from over-crowding and defective ventilation of tents, and huts, were a frequent predisposing cause of zymotic disease." And that, "as the neglect of the sanitary condition of camps, tents, barracks, and hospitals has hitherto, in all countries, climates, and seasons, been the cause of the largest amount of loss in armies, the whole subject (closely connected as it is with the physical efficiency of Her Majesty's forces) demands in future a *practical development* commensurate with its importance to the public service."

During the last three years and five months of the Peninsular war, at the period when the greatest activity prevailed, the mean strength of the British Army amounted to 61,511 men, and the sick to 13,815, being 22½ per cent. The mean ratio of inefficiency from wounds did not exceed 1½ per cent.

The average strength of the British Army in the Crimea during the ten weeks intervening between the 5th May and 14th July, 1855, was 38,507 men. The total admissions into hospital were 22,541, or 58 per cent. of the force; the per-centage of deaths from wounds (exclusive of deaths in the field) was 20 per cent.; whereas 74½ per cent. admitted into hospital, and 96 per cent. of the total mortality from disease, originated from zymotic cases, such as fevers, &c.

Major Rhodes' Tents.

With the view of supplying a remedy for the several defects of the present army tents, I will now briefly describe some tents of my own invention, not that they being my own merit a greater attention, but that I believe the proposed improvements will materially add both to the health and comfort (in all countries and seasons,) of dwellers in tents, and I further hope, may render "Tents and Tent-Life" more acceptable.

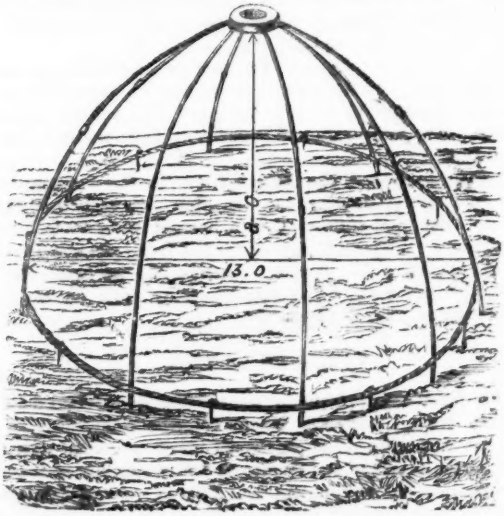
From the diagrams you will perceive that I have applied my system to three forms of tents, in all of which the same principle of construction is embodied.

No. 1 represents the skeleton or uncovered frame of my field-tent, from which you may easily comprehend the simplicity and strength of its construction.

The frame is composed of stout ribs of ash, bamboo, or any other flexible material. When required to pitch the tent, the prepared double-twisted ground rope or band is hooked together, and laid to the full extent of its own circle on the ground; the butt-ends of the flexible ribs are then inserted within the loops or openings already made in the circular rope, and, when the latter has been stretched out to the form required, the butt-end of each rib is forced into the ground (see Diagram No. 2, p. 247); and to facilitate this operation, the extremity of the rib is provided with a metal

shoe in the shape of a wedge. The butt is also provided with stops, so that the twisted rope or band, now circulating round the butt, cannot slip up the rib, nor can the butt be forced into the ground beyond those stops.

To render the ground-rope more secure, a peg is driven over it at the centre point between each rib. The top ends of the ribs (if detached from the butts) are placed into sockets, which latter are secured to the top ends of the butts; the ribs are now gradually bent inwards, and then inserted into the socket-holes of a head prepared for them. The latter has a large hole through its centre for providing top ventilation to the tent. The canvas covering of the tent is then drawn over the frame, and when the outer ventilating head-piece, or hat, covers the inner one, the bottom part of the tent-covering is strapped to the ground-band by means of straps fixed to the inside canvas of the tent, near its base.

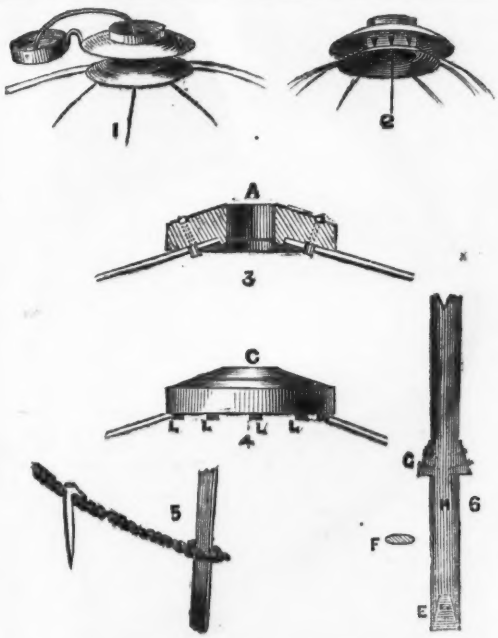


No. 1.

No. 3 (see p. 248). The tent is thus complete; but, to add increased stability, eight short outside storm-ropes, previously attached to the canvas, are stretched out, and pegged to the ground. To further add to the firmness of the structure, the outside valise or canvas bag in which the whole tent was rolled up, is divided into two parts, and then secured to the inside of the lower part of the canvas of the tent, to fastenings prepared for that purpose. On that part of the canvas which lies on the ground, are placed the butt-ends of the arms, the knapsacks, and other articles usually required by a soldier in the field; by this extra weight being laid on the canvas ground-curtain at the sides of the tents, all round its base, not only greater stability is given to the tent, but what materially benefits the men in a sanitary point of view, is, that the usual ground currents of air which

enter at the bottom of the tent do not by the above means blow direct on the bodies of the men, thereby obviating the necessity of providing straw to place round the bottom of the tent, which at present is absolutely necessary to prevent the men from getting stiff necks; by this simple arrangement the purchase of straw usually supplied for tents is obviated; and what must be clearly perceived, is, that fewer men are liable to catch cold, consequently the hospitals would be much less incumbered, and the army rendered much more efficient. It is the prevention, and not the cure of such trivial complaints, that should be most attended to. When it is

[*See p.* 250.



No. 2.—SECTIONAL (ETC.) DETAILS OF MAJOR RHODES' TENTS.

No. 1. Represents outside of the ventilating hat of "Guard," "Field," and "Hospital Tents (top part open)."

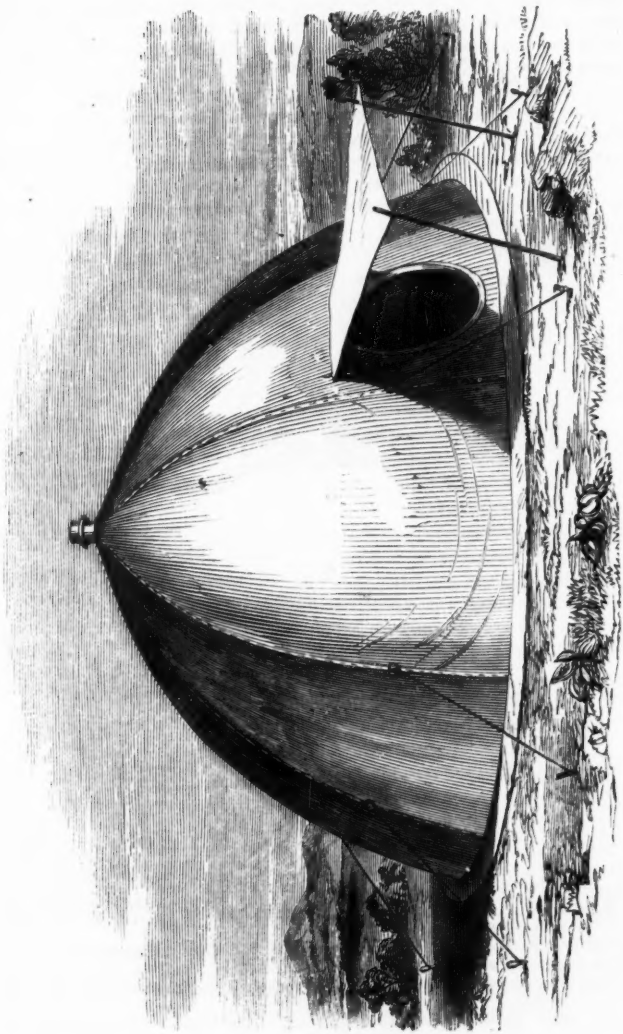
„ 2. Inside of ditto, and cord for closing the top part of the ventilating hat.

A 3. Section of the wooden head-piece.

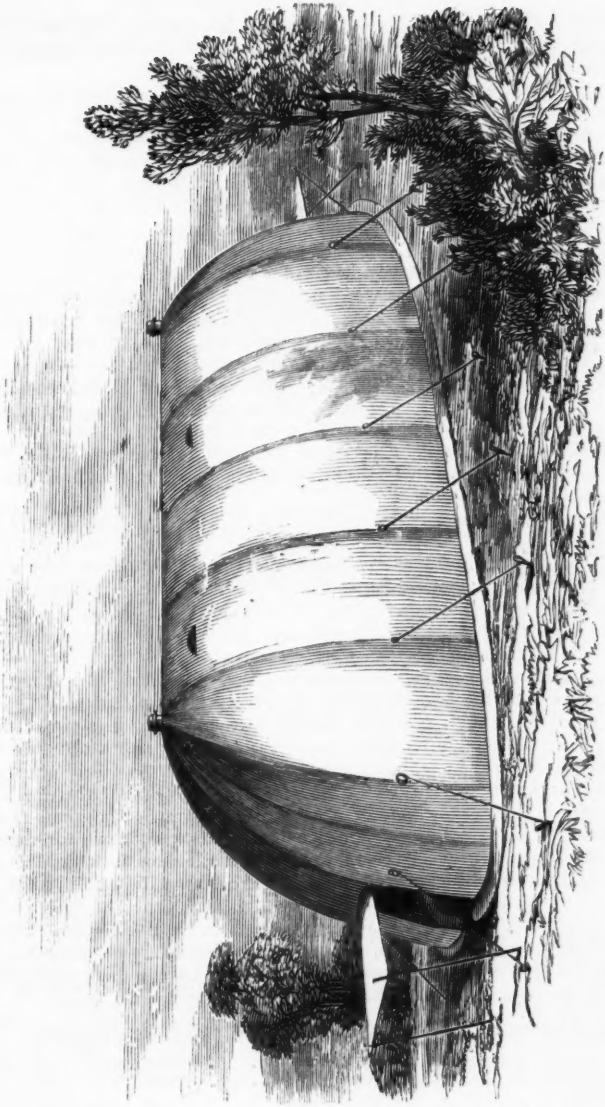
C 4. Side elevation of ditto, showing the iron sockets (L) which receive the top ends of the ribs.

5. Portion of ground-rope, with the butt-end of the tent-rib passed through the rope; also a tent-peg to secure the ground-rope, between each of the ribs.

6. E. section of butt-end of tent-rib, 14 ft. 2 in. long, 2 by ⅝ in. at butt, 2 by ½ in at the top. G. cast iron stops, secured with iron screws. H. tent-rib, of ash or other flexible wood or suitable material.



No. 3.—MAJOR RHODES' FIELD-TENT.



No. 4—MAJOR RHODES' HOSPITAL-TENT.

necessary to light a small fire within the tent, the exterior ventilating hat or cover can be opened, so that an easy and free egress for the smoke is obtained.*

With respect to the saving of space, when ground is an object, I can pitch five of my hospital-tents on the same number of square yards of ground, as is required to pitch (including room for the tent-ropes) one Government hospital-marquee—thus, one of the latter requires about 340 square yards of ground (or 20 paces by 19), whilst five of the former only require about 315 square yards of ground. The space necessary for one of my hospital-tents is about 63 square yards, or about 7 paces by 9.

This is a decided advantage when but a small space can be procured for the encampment of troops. My field-tents can, if required, be pitched within a few inches of each other, thereby also occupying much less space than the "circular conical Government tents."

The cube quantity of air contained in my tents is as follows:—

"*Hospital-tent*," 30 feet long, 15 feet wide, and 10 feet high, is equal to 2383½ cubic feet; or about 119 cubic feet for each soldier, having 20 men in the tent; or for 30 men, about 79½ cubic feet each.†

"*Field-tent*," 13 feet diameter and 8 feet high, is equal to 531 cubic feet; or, for 8 men in a tent, about 66½ cubic feet each; and for 12 men, about 44½ cubic feet each.

"*Guard-tent*," 9 feet diameter, and 5 feet in height, contains about 159 cubic feet.

An ordinary "single-poled circular conical tent," without any side walls, but occupying the same space of ground, and of the same height and width as my field tent, contains about 354 cubic feet of air, thus allowing about 44½ cubic feet for each man, 8 men in the tent; and about 29½ cubic feet for each man, 12 men in the tent.

I beg to state that all my tents are perfectly ventilated, and that the government tents are deficient in that most important particular.

The number of cubic feet of air allowed to each soldier in many of the barracks in England is only 300 feet, whereas for prisons the rule is 1,000 cubic feet per individual.

The colour of the canvas of my tents is grey, and that of the Government tents is generally white, or a very light colour. The glare from white canvas is not only very objectionable for the eyes, but is also easily seen from a great distance, thereby often disclosing to the enemy those strategical movements of which, if the colour of our tents were of a dark-grey, he would be ignorant.

In conclusion, I beg to read a few extracts from Official Reports on the "Suitability, &c., of my Tents," as applicable for military purposes, based on Reports of their actual occupation by troops in the field, which his Majesty the King of Hanover has been pleased to grant me.

* Weight of "Field Tent" (13 feet in diameter), when complete, 95 to 100lbs.

† Weight of Army Hospital Tent . . 507 lbs.
„ Rhodes' Hospital „ . . 395 „
In favour of Major Rhodes' Tent . . 112 lbs.

Extracts from "The Hanoverian Government Reports."

COLONEL RICHERS' REPORT.

(Translation.)

To Major and Adjutant-General von Tschnirschnitz, Hanover.

Celle, *Oct. 12th*, 1858.

In fulfilment of an official request of the 12th ultimo from your Excellency, to his Excellency Leiutenant-General von Dachenhausen, commanding the 1st corps division of the 10th Federate army corps, there were brought me in the camp at Wülfingen, three tents of a new invention of the British Captain Rhodes, with the gracious commands of His Majesty the King, to pitch them in the camp of the Second Regiment of Infantry; to examine them, as to their suitability and durability, and to furnish your Excellency, on return to garrison, with a Report of the information obtained.

Captain Rhodes calls these tents—

"Hospital Tent," called *Tente d'Ambulance* in the French printed paper I received.
"Field Tent," *Tente de Campement* in the French print; and
"Guard Tent," *Tente de Poste ou d'Abri* in the French print.

These three tents differ essentially in their construction from our linen encampment tents, in that the principal support does not consist in the tent pole, but in ribs, the upper part of which is flexible; thus forming a vaulted frame, over which the covering is placed. From this arched shape, the interior space of the tent is much increased from top to bottom; the men can stand upright without difficulty (this is not the case, however, with the very low watch tent), and the middle area of the tents is not diminished by the pole. There is a very useful arrangement within these tents for placing the muskets and accoutrements of the men, which, while but slightly decreasing the interior space of the tent, affords much convenience to the soldier.

This arm-rack sling is composed of two short ropes (each about six inches in length), having a loop-sling and wooden toggle or pin, at alternate ends:—these ropes are fixed to the canvas sides of the tent at about three feet off the ground, but, at the juncture of that part of the canvas which touches the ribs, so that by placing the butt ends of two muskets on the inside ground curtain, at, or close against the butt end of the rib (which has been forced into the ground), and by circulating round the top end of the barrels the two short ropes, and then fastening the latter, the muskets are securely and handily placed upright against the sides of the tent. The accoutrements can be hung over the ropes, between the canvas of the tent and the barrels of the muskets, which, by the projection of the latter beyond the ropes, the accoutrements cannot slip off. Thus, for every two soldiers lodging within the tent, there is one sling, and on account of only two muskets being placed in each loop, the soldiers can readily lay hold of their own arms and accoutrements, even in the dark, without the slightest confusion or delay.

The covering of the tents is of double white cotton canvas, sewed together. During the weather we had at the camp at Wülfingen, the tents were much warmer in the cool of the night than our linen ones, and much cooler than the latter, in the heat of the day. In this respect Captain Rhodes's tents have a twofold advantage over the linen tents of the Government. The pitching and striking of these tents offer no difficulties. The non-commissioned officers and privates under my orders learned the way after once seeing a tent pitched by the armourers (*zeughaus-officianten*) sent me for that purpose.

Eight men, after very moderate practice, can pitch an hospital tent in from ten to twelve minutes; and four men a field tent in five minutes; the same with a guard tent.

After these general observations, I will proceed to give more special details of each tent.

I.—THE HOSPITAL TENT.

This tent is highly to be recommended for camps. It is 30 feet long, 15 wide, and 10 high, and can conveniently accommodate twenty patients. It has the form of a long oval; and when ten patients lie down on each side of the tent, there is sufficient space left in the middle for a small passage, so that the doctor can reach every patient with ease. As soon as the tent was pitched in the camp at Wülfingen, and furnished with straw, I had it occupied by the camp patients of the regiment, hitherto lodged in straw huts. They all expressed themselves (in reply to my inquiries) much pleased with the change; the head surgeon [Dr. Neuber] also frequently informed me, that the tent was excellent, and by far surpassed the straw huts. There are also slings fastened to the walls of this tent (such as I have previously mentioned) for the purpose of supporting the arms, so that the patient can take all his things with him into the tent without being incommoded.

This "Hospital Tent" (as before observed) differs considerably in shape and size from the field tent. It has a larger exterior expanse and head-room, which not only permits of the soldiers standing upright, but supplies a much purer and larger circulation of air. There is another canvas covering, of blue and white striped cotton stuff, which is stretched over the whole of the interior arch of the tent, so that this tent is provided with a threefold covering; the ingress of heat or cold, is, by this means, very much moderated. There are, moreover, in the upper part of the arch, several ventilating holes, which can be opened and closed at pleasure. By this means, the atmosphere of the tent can be kept perfectly pure, and without inconvenience to the patients; and, as these ventilators are only made through the double canvas covering, and not through the under one, the exterior air, on entering within, and near the apex of the tent, is checked by the third, or inside covering, thus only reaching the interior of the tent with a gentle current. In short, this tent answers every purpose that can be desired for an invalid tent.

II.—THE FIELD TENT.

This tent (or the soldier's camp tent) has also the advantages of its arched shape being better adapted for enabling the soldiers to stand upright than is the case with our present linen tents; that the tent-ribs do not limit the interior space; that the arms, without occupying room, can be strapped or secured to the tent-wall, and that the canvas covering does not allow heat and cold to enter so easily as in our linen tents. Besides the above important points, the tent has another good arrangement, viz., that at the top of the dome there is a ventilating hole, so that when the tent is closed all round at its base, as during the night-time, still there is a continuous current of fresh air, entering at the top of the tent; and in warm weather, when the tent doors are both opened, a cool current of air is obtained: this aperture is protected against the entrance of wet by a leathern hat. I may mention as a further utility, that the ground curtain (with which all the three tents are provided), is a sort of canvas carpet, which is buttoned to the lower part of the canvas inside of the tent, covering about two feet of the ground. This ground curtain is used to place the men's things on, such as their knapsacks, arms, &c., and affords also this advantage, that, by the weight placed on it, it materially assists in maintaining the stability of the tent in stormy weather.

The men whom I placed in this tent scarcely ever required their woollen blankets during the night, while those in the linen tents could not do without them—a proof how very much warmer it was in the former. The men gave a decided preference to this tent over the linen one of the Government.

III.—THE GUARD TENT.

This tent seems intended for active war purposes or outposts only. With the object, probably, of its better escaping the observation of the enemy, it is of grey colour, and so low and small (five feet high by nine feet in diameter), that only about six men can conveniently sit in it. In my opinion, its only use can be to afford alternate shelter in bad weather to men on outpost duty.

(Signed) RICHERS,
Colonel, and in command of the Regiment.

DR. NEUBER'S REPORT.

CELLE, *March 8th*, 1859.

MAJOR RHODES' "Hospital Tent" (tente d'ambulance) is 30 feet long, 15 wide, and 10 high, and is of an oval form, and of a vaulted construction. Instead of a tent-pole, wooden bowed ribs serve as a support to the tent. The covering of the tent is composed of double white cotton canvas sewed together. Underneath this canvas covering, there is another composed of blue and white striped cotton, which is stretched over the entire arch of the tent, and is capable of being lowered or raised, according to circumstances. In the upper part of the exterior tent-covering there are two ventilating holes, made to open and shut, which, by reason of the air that permeates through them, keeps the atmosphere between the outer and inside coverings always fresh and pure.

The tent was pitched in the camp of the right wing of the regiment, on a somewhat rising ground, and remained ten days under my superintendence.

The weather was always favourable, although it was hot and dusty during the day, while at night it was often very cool.

The greatest number of patients occupying the tent, at any one time, was 18, of which several had previously been treated in the straw huts.

When hospital accommodation is required for troops in the field (either with reference to the employment of tents or huts), the three following very important points are to be considered:—

"I.—Sufficient light."

"II.—Sufficient accommodation, with as much comfort as possible for the sick, and for the unrestricted movements of the surgeon."

"III.—Purity of the air, and the greatest possible protection against the influence of temperature and weather."

As the above points form the ground of the following report on "Rhodes' Hospital Tent," I take occasion, at the same time, to notice the advantages and disadvantages of the straw hut in these particulars, with the view of corroborating still more my previously delivered opinion, viz. that the former deserves the preference.

I.—SUFFICIENT LIGHT.

The canvas coverings of "Rhodes' Hospital Tent" permit of a thorough, sufficient, and uniform light penetrating through them during the day-time, so that the surgeon has the advantage of being able to make his examinations, and effect every necessary arrangement in any part of the tent in which his patients may be lying, and in whatever position they may be placed.

The strong rays of the sun penetrate the outer and inside coverings of the tent in such a modified form as to neither distress the eyes of the patients, nor incommode the medical officer; on the contrary, in the straw hut, the light fell partially and insufficiently through the window; and, at the examination of the patients, the door was generally obliged to be opened, so that they might be brought near to it. When the door was thus thrown open, it was hardly possible for the surgeon to avoid standing in his own light, which, for example, in dental operations, is an evident disadvantage. In stormy and wet weather, the defective light in the straw hut was of still more serious consequence.

II.—SUFFICIENT ACCOMMODATION, WITH AS MUCH COMFORT AS POSSIBLE FOR THE INVALIDS, AND THE FREE MOVEMENT OF THE MEDICAL OFFICER.

"Rhodes' Hospital Tent" can in case of necessity accommodate twenty invalids (viz., ten on each side), with a space of three feet by six feet six inches for each man. As the invalids lie with their heads near the walls of the tent, and their feet inwards, sufficient space is left in the centre of the tent for a passage through its entire length, from which the surgeon can easily inspect every patient; on the other hand, the invalid can make his way in and out of the tent without disturbing his neighbour. With patients to the number of eighteen, I could reach every man without any inconvenience, and there was still sufficient room for each invalid to have a drinking vessel, &c., placed near him. It is therefore evident that, from the above ample space and arrangements, "Rhodes' Hospital Tent" *affords the best shelter hitherto obtained in camp hospitals.*

A great advantage is also afforded from the height and vaulted form of the tent, as both the surgeon and patient can move about without stooping; moreover, the patient does not lie under a slanting and narrowing roof (running up to a point over his face), as in the straw hut, and in the ordinary camp tent.

Besides this, each tent-rib (on which the accoutrements of the soldier are hung, without any inconvenience to him) serves as a fixed point for the bed-place of each patient, by which a regular and orderly arrangement for their lying down is easily secured.

These proportions of space (as above-mentioned) belonging to this Hospital Tent, stand out *so prominently*, when compared with those of the straw hut, that no further explanations can be required in this particular.

III.—PURITY OF THE ATMOSPHERE, AND GREATEST POSSIBLE PROTECTION AGAINST THE INFLUENCES OF TEMPERATURE AND WEATHER.

The air in "Rhodes' Hospital Tent" was always pure and wholesome, even in the morning, after the entrances had been closed the night before; it was equally so in the daytime, when the rays of the hot sun fell strongly on the tent.

The construction of this tent, with its system of ventilation, not only permits of a gentle circulation of air within, but also materially contributes in maintaining that air in a pure and wholesome state: on the contrary, in the straw hut, the atmosphere was never so pure and wholesome, and this was more particularly felt in the morning, after the door and window had been closed during the previous night. In connection with this subject, I may observe, that in the straw huts at the camp of Nordstemmen, millions of little flies made their appearance, soiling everything they touched; but in "Rhodes' Hospital Tent," as well as in the other two tents, no trace of them was visible. The temperature in his tent during the heat of the day was higher than in the straw hut, but at the same time was not disagreeable, and never obtained such a degree of heat as in the ordinary simple camp tents. During the cool nights, it was equally as warm in this tent as in the straw hut; but in the latter, the wind blew through every crevice, so that the night-air caused a very perceptible draught: on the contrary, owing to the strong material of which the outside double covering of "Rhodes' Tent" is composed, this current of night-air nowhere penetrated through it, and I have been *repeatedly* assured of this fact by patients who had previously occupied the straw hut. For the more accurate observation of the variations of temperature I required a thermometer, but unfortunately had none.

It is to be observed that the temperature in this tent can be raised by the *lowering* of the inside cover in cold weather, and in hot weather, moderated, by *drawing it up*. I could however make no closer inspection on this point, since the weather continued, as before remarked, sufficiently warm in the tent, even during the night.

With respect to "Rhodes' Hospital Tent" resisting storm and rain, I can form no opinion from personal experience; but I think, from experiments which I made with the straw huts on the Düppler Höhen, and with the simple camp tent in the camp at Lüneburg, I may venture to state, that his Hospital Tent would be more secure against wind and storm than a straw hut, and amply as well against rain.

In conclusion, I must also mention that all the invalids who had occupied "Rhodes' Hospital Tent" spoke in high terms of it in every particular, and repeatedly of their having lived in it; besides, all the patients who had occupied both the straw huts and his "Tent" decidedly preferred the latter.

(Signed) DR. NEUBER,

Head Surgeon in the 2nd Infantry Regiment.

ADMIRAL SAUMAREZ drew attention to the fact that cotton cloth, when saturated, throws off the water, instead of allowing it to pass through; and that that was the great advantage of cotton over linen. He stated that a lieutenant in the navy, observing that air could not pass through saturated cotton cloth, had turned this knowledge to account in making a life-belt, which he found sufficiently strong to support him; that he himself had made one, and that several others had been made on the same principle from cotton cloth, and found to answer perfectly.

STIRLING LACON, ESQ. Though cost ought to be no consideration where the health of the men is concerned, will you be kind enough to give us a slight estimate of the cost of a tent constructed on the Government plan as compared with yours, both holding the same number of men ?

MAJOR RHODES. The Government single-poled conical tent costs about £3 15*s.*; a tent of mine, of the same size, would be about £9 9*s.* or £10 10*s.*, both accommodating the same number of men. Mine is of double cotton canvas, which of course increases the price; and then an extra expense is incurred on account of the ropes and the canvas being waterproofed by the present mode of waterproofing cloth, &c. The tents being covered with double cloth, the interior cloth would take a considerable time before its waterproof qualities would be much deteriorated, on account of the water not often touching it. My tents have been tested in Dublin and elsewhere *during very heavy wet weather*, and those tents were *perfectly dry inside*, during and after very heavy rains, on account of the double cloth. The Turkish soldiers' tents are all covered with double cotton canvas.

STIRLING LACON, Esq. I prefaced my question by saying that the cost ought not to be any consideration where the health of the men is concerned.

MAJOR RHODES. I may be permitted to remark, that, though my small field-tent is more expensive, yet my hospital tents are less costly than the Government hospital marquees, both holding the same number of men.

CHAIRMAN. Major Rhodes has, under an unpretending title, read a very interesting paper. The subject is no less important than interesting, when we consider the fact, (of which we are all aware,) that 80 per cent. of the deaths in the Crimea arose from sickness arising from the want of sanitary arrangements. Of course the difficulty in erecting the tents which have a pole in the middle is very considerable; and, if the men are putting the tent up during a storm, it is often capsized before it is finally erected. In Major Rhodes' tents the covering is not put on till the framework is up, and the covering of the tent is therefore comparatively easy. I think I should begin to build the framework from the top, though perhaps that is not the ordinary way of building; but it appears to me that if the top frames were first inserted in the round top, or head-piece, and then bent, the lower frames would be fixed easily into the ground.

MAJOR RHODES. I have tried it both ways, and I find that the best way is to erect it from the bottom. The frames of the Hospital, and other larger-sized Field-tents, are erected as the Chairman describes.

CHAIRMAN. Of course I do not pretend to be competent to speak as to that. . . . . I may add, that Major Rhodes has received a gold medal from the Emperor of Austria in testimony of His Majesty's high approbation of his (Major Rhodes') improvements in tents.